Chapter 3

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter provides background by describing the study area and discussing the past cumulative effects of historical development on study area resources. It then describes the resources that could potentially be affected by modifying operations of Truckee River reservoirs and the effects of the alternatives on these resources. Affected resources are surface water and groundwater resources, including water quality and sediment and erosion; biological resources, including endangered, threatened, and other special status species; recreation; economic, social, and cultural resources; and Indian trust resources. This chapter also discusses Newlands Project operations, minimum bypass flow requirements for the four hydroelectric diversion dams on the Truckee River, water right change petitions and applications, growth-inducing impacts, environmental justice, unavoidable adverse impacts, the relationship between short-term uses and long-term productivity, and irreversible and irretrievable commitments of resources. (Attachment F provides additional perspective on Donner Lake.) Map 3.1 shows reaches of the Truckee River as they are designated in this document.

BACKGROUND

This section describes the location, geology, and climate of the study area. These factors would not be affected by modifying operations of Truckee River reservoirs but could influence them. This section then discusses the past cumulative effects of historical development on study area resources.

I. Study Area Setting

A. Location

The study area is located in the Great Basin, a 188,000-square-mile region that includes most of Nevada and portions of eastern California and western Utah. Great Basin stream systems drain internally instead of to an ocean. Streams in the Great Basin are generated from snowpack in high mountain ranges and terminate in sink areas that may contain lakes, wetlands, or playas.

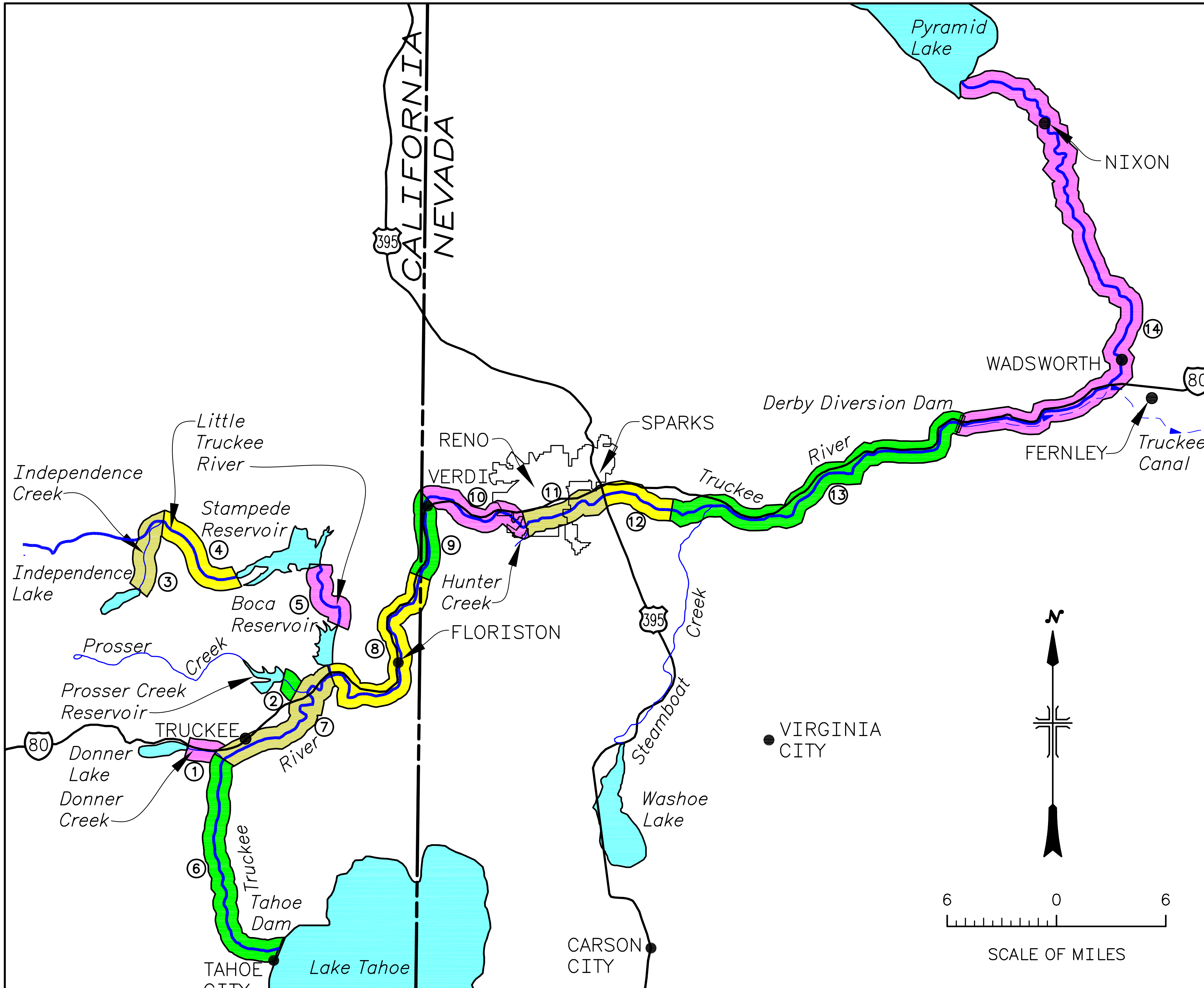
The study area includes the 3,060-square-mile Truckee River basin in east-central California and northwestern Nevada, the Truckee Division of the Newlands Project (i.e., served by the Truckee Canal), Lahontan Reservoir, and 2,200 square miles of the lower Carson River basin in northwestern Nevada. (See location map.)

The Truckee River originates at the outlet of Lake Tahoe at Tahoe City, California, and flows about 120 miles to its terminus in Pyramid Lake, located within the Pyramid Lake Indian Reservation. Truckee River water is diverted at Derby Diversion Dam (located about 36 miles upstream of Pyramid Lake) via the Truckee Canal, according to Operating Criteria and Procedures (OCAP) for the Bureau of Reclamation's (Reclamation) Newlands Project. The Truckee Canal extends about 32 miles through the Truckee Division of the Newlands Project to Lahontan Reservoir, located in the Carson Division of the Newlands Project in the lower Carson River basin. Lahontan Reservoir also captures Carson River inflow. The lower Carson River originates at the outlet of Lahontan Reservoir, flows about 50 miles through Lahontan Valley, and terminates in Carson Sink.

From a hydrologic standpoint and for the purpose of defining the study area, the Truckee River basin includes the area that drains naturally to the Truckee River and its tributaries, and into and including Lake Tahoe (Lake Tahoe basin) and Pyramid Lake. From an administrative standpoint and for the purpose of analysis in this document, the Lake Tahoe basin is treated as distinct from the remainder of the Truckee River basin and data and analysis presented in this document address each separately. The crest of the Sierra Nevada mountain range forms the western boundary of the Truckee River basin, with elevations ranging between 5,000 and 10,000+ feet mean sea level (msl). The California portion of the study area is approximately 760 square miles and contains Lake Tahoe and El Dorado, Toiyabe, and Tahoe National Forests in portions of El Dorado, Nevada, Placer, and Sierra Counties. Population centers are Truckee, South Lake Tahoe, and Tahoe City.

The Nevada portion of the study area includes one-third of the Lake Tahoe basin with its high alpine setting; the remainder is mostly a high desert that drops to an elevation of about 3800 feet near Pyramid Lake. The study area in Nevada includes parts of Churchill, Douglas, Lyon, Pershing, Storey, Carson City (only the rural portion) and Washoe Counties. Communities in the Lake Tahoe basin include Incline Village, Glenbrook, and Stateline. In the Truckee River basin, the Reno-Sparks metropolitan area (Truckee Meadows), located in Washoe County is the principal population center; other centers include Fernley and Fallon, which are included in the study area but are not within the Truckee River basin. Approximately one-half of the study area in Nevada is Federal land, variously managed by Reclamation, Bureau of Land Management, U.S. Fish and Wildlife Service (FWS), and U.S. Navy. Naval Air Station Fallon (NASF) has a major flight training facility near Fallon.

The study area has three Indian reservations. The Reno/Sparks Indian Colony is located in Reno in an urban environment. The Pyramid Lake Indian Reservation surrounds Pyramid Lake and the lower reach of the Truckee River and includes the communities of Sutcliffe, Nixon, and Wadsworth. The Fallon Paiute-Shoshone Indian Reservation is near Fallon and includes lands adjacent to the Newlands Project. Additionally, the Washoe Tribe of Nevada and California holds interests in the Lake Tahoe basin.



EXPLANATION OF REACHES

1. Donner Creek: Donner Lake to Truckee River
2. Prosser Creek: Prosser Creek Reservoir to Truckee River
3. Independence Creek: Independence Lake to the Little Truckee River
4. Little Truckee River: Independence Creek to Stampede Reservoir
5. Little Truckee River: Stampede Reservoir to Boca Reservoir
6. Truckee River: Lake Tahoe to Donner Creek
7. Truckee River: Donner Creek to Little Truckee River Confluence
8. Truckee River: Little Truckee River to State line
9. Truckee River: State line to 3.2 miles downstream (Trophy)
10. Truckee River: 3.2 miles below State line to Hunter Creek (Mayberry)
11. Truckee River: Hunter Creek to U.S. Highway 395 (Oxbow)
12. Truckee River: U.S. Highway 395 to E. McCarran Blvd. (Spice)
13. Truckee River: E. McCarran Blvd. to Derby Diversion Dam (Lockwood)
14. Truckee River: Derby Diversion Dam to Pyramid Lake (Nixon)

Map 3.1 Reaches of the Truckee River Basin

Wetlands in the vicinity of the Truckee Canal—Massie and Mahala Sloughs and Fernley Wildlife Management Area (WMA)—are supported in part by drainage from the Truckee Division of the Newlands Project. Wetlands in the lower Carson River basin, such as Stillwater National Wildlife Refuge (NWR) and Carson Lake, are remnants of a once-extensive marsh system and are now supported in part by water rights and drain water from the Carson Division of the Newlands Project.

B. Watercourse of the Truckee River

The Truckee River originates at the outlet of Lake Tahoe, which is fed by 63 streams that drain the Lake Tahoe basin. It is one of the world's deepest lakes and is renowned for its clarity. Lake Tahoe has a surface area of 192 square miles and a watershed area of 314 square miles. It has an average water depth of 1027 feet, a maximum depth of 1646 feet, and about 71 miles of shoreline. Lake Tahoe Dam, on the northwestern shore at Tahoe City, controls the top 6.1 feet of the lake as a reservoir to store and release water for Floriston Rates. Floriston Rates, which are prescribed flows in the Truckee River, provide water to serve hydroelectric power generation, municipal and industrial (M&I) use in Truckee Meadows, instream flow, and numerous agricultural water rights. (See location map.)

From Lake Tahoe Dam, the river flows north for about 15 miles to the town of Truckee, where it is joined by Donner Creek. Donner Creek is regulated by a dam on Donner Lake. Truckee Meadows Water Authority (TMWA) and Truckee-Carson Irrigation District (TCID) jointly own storage rights in Donner Lake.

About 1 mile downstream from Truckee, the river passes (and receives subsurface discharge from) the Tahoe-Truckee Sanitation Agency water reclamation facility (TTSA). TTSA serves the Tahoe City Public Utility District, North Tahoe Public Utility District, Alpine Springs County Water District, Squaw Valley Public Service District, Truckee Sanitary District, and Northstar Community Services District.

About one-half mile downstream from TTSA, the river is joined by Martis Creek. Three miles farther downstream, the river is joined by Prosser Creek. These creeks are regulated by the federally-owned Martis Creek and Prosser Creek Reservoirs, respectively.

Three miles downstream from Prosser Creek, the river is joined by its largest tributary, the Little Truckee River. The Little Truckee River is regulated by a dam on Webber Lake (privately owned) and by Stampede and Boca Reservoirs (federally owned). A tributary to the Little Truckee River, Independence Creek, is regulated by a dam on Independence Lake, which is owned by TMWA. About 5 miles downstream from the Little Truckee River confluence, Gray Creek enters the Truckee River; it is notable for discharging large quantities of mud and debris during heavy rains.

About 4 miles downstream from Gray Creek, the river enters Nevada near Farad, California, site of a key U.S. Geological Survey (USGS) stream gauge. Floriston Rates are measured at the Farad gauge. From Farad, the river passes the town of Verdi and flows east about 15 miles to Truckee Meadows. TMWA owns four hydroelectric plants along the Truckee River between the Little Truckee River and Truckee Meadows.

Truckee Meadows is a high desert valley bounded on the west by the Carson Range of the Sierra Nevada, on the east by the Virginia Range, and on the north and south by low hills. The Truckee River flows through downtown Reno, providing a setting for numerous municipal parks. Several small tributaries join the Truckee River in Truckee Meadows, the largest of which, Steamboat Creek, originates at the outlet of Washoe Lake and drains the southern and eastern parts of Truckee Meadows.

On the east side of Truckee Meadows at Vista, the river enters the Truckee River canyon. About 14 miles past Truckee Meadows, the river reaches Sierra Pacific's Tracy-Clark power station cooling ponds. About 4 miles past the ponds, the river reaches Derby Diversion Dam. Twenty miles downstream, the Truckee River enters the Pyramid Lake Indian Reservation and turns north at Wadsworth. The river flows for another 17 miles to Numana Dam, the diversion dam for irrigation on the reservation. About 8 miles downstream from Numana Dam is Marble Bluff Dam, which is designed to reduce erosion along the lower Truckee River. Also at the dam, a fish lock, constructed in 1998, and the Pyramid Lake Fishway aid the migration of Pyramid Lake fishes.[1]

Pyramid Lake, the terminus of the Truckee River, is 30 miles long, 11 miles wide, and covers about 169 square miles at a surface elevation of 3800 feet msl. Immediately east of Pyramid Lake is the bed of Winnemucca Lake, which dried up in 1938.

At Derby Diversion Dam, Truckee River water is diverted to the Newlands Project via the Truckee Canal in accordance with OCAP. The 32-mile canal provides irrigation water to lands near Fernley and Hazen in the Truckee Division and to Lahontan Reservoir for use in the Carson Division, on Fallon Indian Reservation, and on Stillwater NWR, a total of about 60,000 water-righted acres.

C. Geology

The current topography of the study area began to take shape about 25 to 40 million years ago. During that time, a block of granitic rock was tilted up on its east side to form the present-day Sierra Nevada. To the east, great faults broke the earth's surface, and volcanoes discharged lava and ash over much of the landscape. Uplifted, north-trending blocks formed mountain ranges, and downdropped blocks formed valleys.

By about 2 to 3 million years ago, volcanic activity had subsided, the climate was becoming predominantly cool and wet, great glaciers formed to the north, and lakes filled many of the valleys of the Great Basin. At times, the lakes expanded beyond their

[1] Federally endangered cui-ui and threatened Lahontan cutthroat trout (LCT) are collectively referred to as Pyramid Lake fishes.

valleys and coalesced to form huge lakes. One of these lakes was Lake Lahontan, which covered much of northwestern Nevada and a portion of northeastern California. At its maximum stage, about 50,000 years ago, Lake Lahontan occupied about 8,500 square miles. About 10,000 years ago, the climate began to warm, precipitation decreased, and Lake Lahontan receded until only a few remnants of the lake—Walker Lake, Honey Lake, and Pyramid Lake—remain today.

The historical geology continues to have localized influence in the study area. Throughout the Truckee River corridor, the bedrock is variably volcanic, metamorphic, and, in the lower reaches, sedimentary. In the lower Truckee River basin, thick unconsolidated sedimentary deposits exist that have become deeply excised as the elevation of Pyramid Lake declined. Exposed tufa, calcium carbonate deposits that formed below the surface of the lake, provide evidence of a historically higher elevation.

Downstream from Lahontan Reservoir, the geology becomes a complex combination of deposits consisting of organic-rich clays, sands, and gravels. These sediments also contain varying amounts of salts, which is typical in an internally drained basin in which minerals remain after water evaporates.

D. Climate

The climate of the California portion of the study area is characterized by cold, wet winters and short, mild summers. The climate of the Nevada portion of the study area is typical of the Great Basin, with long, dry winters and short, dry summers.

In the Sierra Nevada, precipitation falls almost exclusively as snow from November to April (85 percent of annual precipitation). Most Truckee River runoff results from snow that accumulates on the eastern slope of the Sierra Nevada in the winter and melts in late spring and early summer. Summer thunderstorms are common but produce little precipitation. Lowest annual precipitation recorded at Tahoe City (elevation 6230 feet msl) was 9.34 inches (1976); highest annual precipitation was 66.41 inches (1996). Average annual precipitation is about 32 inches. Highest temperature recorded at Tahoe City was 94 degrees Fahrenheit (°F) (August 1933); lowest recorded temperature was -16 °F (December 1972). Average August temperature is about 61 °F; average January temperature is about 29 °F.

The Sierra Nevada also greatly influences the climate of the Nevada portion of the study area. The prevailing winds are from the west. As the warm, moist air from the Pacific Ocean ascends the western slopes of the Sierra Nevada, the air cools, condensation occurs, and most of the winter moisture falls as snow; but, as the air descends the eastern slope of the Sierra Nevada into Nevada, it warms, and very little precipitation occurs.

Above 5000 feet, precipitation usually falls as snow. Lowest annual precipitation recorded at Reno (elevation 4397 feet) was 1.55 inches (1947); highest annual precipitation was 13.73 inches (1890). Average annual precipitation is about 7.5 inches.

Climate in the Nevada portion of the study area is semiarid to arid, and summers are characterized by clear, warm days and cool nights. Winters are not severe, with temperatures rarely dropping below 0 °F. Highest temperature recorded at Reno was 108 °F (July 2002); lowest temperature on record was -19 °F (January 1890). Average August temperature is about 70 °F; average January temperature is about 33 °F.

The historical hydrology of the study area is characterized by periods of droughts and flooding. Drought is a long period of abnormally dry weather affecting a relatively large area. The two most severe droughts on record occurred from 1928 through 1935 (average annual discharge at Farad of 303,240 acre-feet) and from 1987 through 1994 (average annual discharge at Farad of 286,350 acre-feet). The lowest recorded flow at Farad was 37 cubic feet per second (cfs) in September 1933.

Major flooding events occurred in 1907, 1909, 1928, 1937, 1950, 1955, 1963, 1983, and in January 1997. The "high water year" in the Truckee River basin is 1983, when Truckee River annual discharge recorded at the Farad gauge was 1,769,000 acre-feet (Nevada, 1997a).

E. Public Trust Doctrine

In California, the public trust doctrine has historically been referred to as the public's right to use California's waterways to engage in commerce, navigation, and fisheries. More recently, however, the definition of this doctrine has been expanded by the courts to include the use of California's water resources for environmental preservation and recreation; ecological units for scientific study; open space; environments which provide food and habitats for birds and marine life; and environments which favorably affect the scenery and climate of the area.

II. Past Cumulative Effects

This section describes the cumulative effects that settlement, logging, mining, and irrigation projects have had on the study area's resources. The discussion focuses on the period beginning with immigration from the eastern United States (about the mid-1800s) until the present. The first subsection provides an overview of past cumulative effects in the study area; subsequent subsections describe the cumulative effects of these changes on individual resources. Chapter 4 provides a discussion of the cumulative effects of future actions on the study area's resources.

A. Overview

1. Early Exploration and Settlement

Humans have inhabited the Lake Tahoe, Truckee River, and lower Carson River basins for more than 10,000 years. These early people depended on the abundant fish in the Truckee

River, Pyramid Lake, and Stillwater Marsh for survival. In particular, cui-ui, a sucker fish found only in Pyramid Lake and the lower Truckee River, was a staple for people in this region; the Pyramid Lake Paiutes were called “Kuyuidikadi” or “cui-ui eaters.”

Spanish explorers knew of the Truckee and Carson Rivers by the end of the 1700s, and trappers and traders first visited the study area in the late 1820s and early 1830s. The area was not systematically explored until John Charles Fremont, who was exploring the Rocky Mountains and northwest, arrived in 1844 from Oregon Territory with guide Kit Carson. Famed for his role as one of the first (post-Lewis and Clark) government-sponsored explorers, Fremont coined the descriptive term “Great Basin” as the vast stretch of semi-arid land between the Wasatch Mountains and Sierra Nevada. Fremont is also credited with naming Pyramid Lake after a prominent rock formation located near the east-central shore.

Following Fremont’s expedition, more prospectors and settlers traversed the Sierra Nevada to California. With the 1848 discovery of gold at Sutter’s Mill near Sacramento, the number of immigrants increased exponentially. While some established trading posts at river crossings along the Carson, Humboldt, and Truckee Rivers to supply the permanent settlers, most of the early settlers of the 1850s and early 1860s became ranchers or farmers.

2. Comstock Era

The Comstock era began in June 1859 with the discovery of gold near Virginia City, Nevada. Silver, however, eventually became the primary ore mined. As with most large-scale mining discoveries in the 19th century American West, the Comstock Lode precipitated a period of unprecedented growth and settlement. For more than two decades, the development and operation of Virginia City’s mines influenced virtually every aspect of life in the study area.

This increased mining activity necessitated heavy water usage, so water was diverted from the Lake Tahoe and Truckee River basins. Additionally, demands for lumber to supply the mines and railroads led to extensive logging and milling operations. This economic activity adversely affected the environment: it denuded vast forest expanses, eroded barren hillsides, and clogged rivers and streams with sawdust and logging debris, which hampered fish migration and degraded water quality and had long-lasting effects on the study area’s natural and cultural environment.

3. Lumber Era

Of the several industries developed in connection with the Comstock, none was more important or widespread than that of supplying lumber for construction purposes and for fuel. By 1861, there were three lumber mills in the study area that served the needs of settlers and prospectors. Most homes, businesses, mines, and mills were constructed primarily of wood. Lumber eventually could only be obtained from Sierra Nevada forests because the pinyon pines found in the desert mountains of the Virginia Range were quickly exhausted (Galloway, 1947).

Water was key to moving timber or finished lumber. Chutes took logs to Lake Tahoe (and holding ponds) from which they were floated to mills. Water flowing through flumes moved finished lumber, wood, and other materials produced by high mills down the mountains at remarkable speeds (Galloway, 1947). By 1880, there were 10 flumes in Douglas, Ormsby (present-day Carson City), and Washoe Counties (Hinkle and Hinkle, 1987).

As discussed in chapter 1, a private timber crib dam constructed in 1870 at the outlet of Lake Tahoe regulated flows in the Truckee River so that logs could be floated to sawmills in Truckee, California. The dam also was used for milling purposes and to generate hydroelectric power. The estimated value of lumber production for the 20 years before 1890 was $80 million, nearly the production total of all of the Comstock mines.

4. Railroads

In spring 1868, the western leg of the first transcontinental railroad, the Central Pacific, reached the California-Nevada border. Among the towns established during construction were Verdi, Boca, Reno, and Wadsworth (Hinkle and Hinkle, 1987; McLane, 1990). Reno was founded in May 1868 when the Central Pacific auctioned lots for a depot and yard to be used as a distribution point. Central Pacific construction supervisor Charles Crocker named Reno after Jesse C. Reno, a Union general killed during the Civil War.

From the new Reno depot, goods and passengers were delivered to the Comstock by road until the August 1872 completion of Virginia and Truckee Railroad, which linked Reno to Virginia City.

5. Farming and Ranching

Long before the arrival of the U.S. Reclamation Service (USRS), settlers in the study area created irrigation ditches. In 1861, construction began on the Pioneer and Cochran Ditches in Truckee Meadows, which provided water for hay meadows (Nevada, 1997a). As early as 1863, hay ranches were established in Truckee Meadows and Lahontan Valley (Raven, 1990). Settlers in the lower Carson River basin initially fed cattle driven from Texas or California on native hay and sold both the cattle and hay to Comstock residents.

Around that time, rock and brush diversion techniques for irrigation were introduced. These techniques allowed ranchers to water hay pastures, enlarging the areas used and speeding the transition from native grasses to alfalfa, introduced in 1864. By 1866, ranchers began to burn tule thickets and plow up and level the sagebrush areas to enlarge meadows and create irrigated pastures.

In Lahontan Valley, the system of open range and irrigated hay ranching grew, fueled by continuing demand from mining. As demand grew, however, competition for land and water increased as did the frequency of disputes. By the late 1870s, ranchers had fenced off much of the previously open range land (Townley, 1977).

In the 19th century American West, when one boom exhausted itself, another usually took its place. In the 1880s, as Comstock mining waned, the “Beef Bonanza” began; demand for beef at the national and international (mostly England) level was greater than supply. The prosperity from beef production in the 1870s and 1880s spawned other business development, including a flour mill in 1881 and an artesian well cooperative. Valley ranchers entered into contracts with stockmen from other locations to feed their cattle during the winter (Townley, 1977).

Then, during the extremely severe winter of 1889-90, more than one-half of the stock died. This created a ripple effect; creditors liquidated ranches not just in Nevada but throughout the West (Townley, 1977). In the early 1890s, extreme drought followed extreme cold, which diminished grasses on the public lands. Cattle competed with sheep, which had become very popular in the State, and with wild horses for forage. An 1893 bill passed by the Nevada Legislature provided for payment of 25 cents for each wild horse killed on public lands, a source of income to Indians and cowboys alike for decades (Townley, 1977).

6. Early Irrigation and Water Projects

Early settlers selected prime spots along drainages and diverted water for irrigating crops and pastures, with increasing reliance on irrigation. By 1879, increased water use throughout the region, combined with continued expansion of beef production, stimulated plans for water storage and, ultimately, for Reclamation projects (Townley, 1977). At that time, water to irrigate land in the Lahontan Valley was diverted directly from the Carson River, with limited supplies in late summer and fall as river flows declined.

It was not until 1902, however, that the Congress passed the National Reclamation Act, which created the U.S. Reclamation Service (renamed the Bureau of Reclamation in 1923). That act authorized the Federal Government to construct irrigation projects in the West, to reclaim lands for widespread cultivation and settlement (Nevada, 1997a). On March 14, 1903, the Secretary of the Interior (Secretary) selected the Truckee-Carson Project (later renamed Newlands Project) as one of the first five such projects (Townley, 1977).

a. Newlands Project

With the authorization of what is now called the Newlands Project, USRS started to map the Truckee Canyon and selected the location for Derby Diversion Dam—the first USRS facility—completed in 1905. That accomplished, the surveyors moved east to map the route of Truckee Canal and lay out water supply and drainage ditches for 200,000 acres of arable land. In 1904, farmers moved onto various parcels of land; most were in six townships around Fallon, with others near the new town of Fernley. In 1906, the first project water was delivered to 108 ranches.

As USRS supplied water to an increasing number of parcels, it became apparent that the original estimates of available Truckee River flow and Lake Tahoe storage were too high. Thus, USRS decided in 1908 to build a storage reservoir on the Carson River. In February 1911, construction began on Lahontan Reservoir near Fallon. The 1914 completion of Lahontan Dam allowed land entry to resume with what was believed to be sufficient water, and from 1914-17, hundreds of settlers arrived in Lahontan Valley.

Additionally, in 1908, after several changes in ownership, the Truckee River General Electric Company, predecessor to Sierra Pacific, signed an agreement with the Floriston Pulp and Paper Company to establish the first Floriston Rates. Between 1909 and 1913, USRS and the Truckee River General Electric Company replaced the original Lake Tahoe crib dam with a 17-foot vertical gate concrete slab structure. On July 1, 1915, the United States assumed control of the dam under the *Truckee River General Electric* decree.

In 1915 distrust of USRS became so intense that entrymen considered organizing a militia to take control of the Newlands Project. Cooler heads prevailed, however, and, in 1918, TCID was organized with the goal of resolving dissatisfaction and management problems.

On December 31, 1926, a contract between TCID and Reclamation transferred management of the Newlands Project to TCID. This transfer, however, still did not solve water supply problems. In the drought years between 1921 and 1934, TCID purchased water from Donner Lake and occasionally pumped water from Lake Tahoe or Lahontan Reservoir.

In 1935, the Truckee River Agreement (TRA) was executed to modify Floriston Rates. TRA also prohibited removing water from Lake Tahoe for other than sanitary or domestic uses by any means other than gravity with proper approvals (Simonds, 1996).

b. Truckee River Storage Project

By the 1920s, farmers upstream of the Newlands Project who advocated increased storage formed the Washoe County Water Conservation District (WCWCD). The September 1935 appropriation for the Truckee River Storage Project authorized design of Boca Reservoir (Townley, 1977). On February 11, 1937, Reclamation approved the design for the Boca facility and executed a repayment contract with WCWCD. In 1942, Reclamation turned the management of Boca Reservoir over to WCWCD.

In 1943, TCID and Sierra Pacific signed an indenture for water rights from Donner Lake. Currently, TMWA, which jointly owns the storage rights with TCID, manages its water for M&I in Truckee Meadows. TCID manages its water for an occasional lease to TMWA for use in Truckee Meadows or to serve irrigation rights in the Truckee Division.

7. Later Irrigation and Water Projects

In 1962, Reclamation completed Prosser Creek Dam and Reservoir, the first Washoe Project facility. Designed primarily to provide additional flood control storage for Truckee Meadows, the facility is also operated to help achieve Floriston Rates. Today, Prosser Creek Reservoir is operated for the benefit of Pyramid Lake fishes, flood control, and the Tahoe-Prosser Exchange Agreement (TPEA). Another Washoe Project facility, Stampede Dam and Reservoir, is operated for the benefit of Pyramid Lake fishes and for flood control. Stampede Reservoir also provides incidental recreational opportunities. It is the second largest reservoir in the basin and the only Truckee River reservoir with a hydroelectric plant, installed in 1988.

In 1971, the U.S. Army Corps of Engineers (COE) completed Martis Creek Dam and Reservoir for flood control. Because the dam leaks (mostly due to the nature of the valley soils it is built on), it provides only temporary flood storage.

In 1975, Reclamation completed the final Washoe Project facility, Marble Bluff Dam and Pyramid Lake Fishway.

8. OCAP and More Recent History

In 1967, Reclamation established the first Newlands Project OCAP. The 1967 OCAP placed a maximum allowable diversion of 406,000 acre-feet on the Newlands Project, and sought to limit Truckee River diversions to the Carson Division. Under the 1967 OCAP, diversion of Truckee River water solely to generate hydroelectric power at Lahontan Dam and at a generating station on the V Canal was halted to reduce diversions at Derby Diversion Dam. Reduced inflow to Pyramid Lake resulting from upstream diversions and diversions to the Newlands Project since the construction of Derby Diversion Dam had caused the lake elevation to drop nearly 80 feet in about 50 years.

In 1970, the Pyramid Lake Paiute Tribe of Indians (Pyramid Tribe) filed suit against the Secretary claiming the 1967 OCAP allowed water to be wasted within the Newlands Project. The suit sought to improve Newlands Project efficiencies, thus reducing diversions at Derby Diversion Dam and increasing inflow to Pyramid Lake. In 1973, a more restrictive OCAP was implemented to maximize the use of Carson River water and to minimize the use of Truckee River water on the Newlands Project. OCAP was modified again in 1988, and most recently in December 1997 to recognize and respond to developing changes in Newlands Project irrigated acreage and land use.

In 1989, the Pyramid Tribe and Sierra Pacific negotiated the Preliminary Settlement Agreement as Modified by the Ratification Agreement (PSA) to change the operation of

Federal reservoirs and the exercise of water rights of the parties to (1) improve spawning conditions for Pyramid Lake fishes and (2) provide additional M&I water for Truckee Meadows during drought periods.

As described in chapter 1, the Congress enacted Public Law (P.L.) 101-618 in 1990 to provide the direction, authority, and mechanism for resolving a number of disputes over water resources and water rights in the Truckee and Carson River basins. Among other actions, P.L. 101-618 directs negotiation of an operating agreement for Truckee River reservoirs (i.e., the Truckee River Operating Agreement [TROA]).

B. Past Cumulative Effects on Affected Resources

1. Water Resources

a. Surface Water

Before the mid-1800s, Lake Tahoe and Truckee River basin lakes and streams were unregulated. During particularly wet years, Truckee River flows were sufficient to feed Winnemucca Lake, adjacent to Pyramid Lake.

Before irrigation in the lower Carson River basin, the flow path of the unregulated Carson River was more dynamic than today, and the river channel frequently changed course during floods. For example, before 1861, the Carson River entered Carson Lake on the northwest side and exited from the northeast corner, flowing into Carson Sink through Stillwater Slough. Heavy Carson River runoff generally inundated parts of the lower basin in late winter and early spring. These waters accumulated in Lahontan Valley, supporting a complex system of open water and wetlands, including braided river channels, closed oxbows, perennial and ephemeral marshes, and playas (Nevada, 1997a).

Management of the reservoirs and diversions of water from the Truckee River have adversely affected Pyramid Lake. Before the early 1900s, fluctuations in the elevations of Pyramid Lake and Winnemucca Lake were primarily due to natural factors. Completed in 1905 as part of the Newlands Project, Derby Diversion Dam became the largest single diversion structure on the Truckee River. After diversions for the Newlands Project began, elevations began a trend of decline and, by 1938, Winnemucca Lake (previously habitat for cui-ui and the site of a national wildlife refuge) was dry. Pyramid Lake reached its lowest historical elevation (3784 feet) in 1967, 80 feet below its overflow elevation into Lake Winnemucca. Lowered Pyramid Lake elevation and reduced streamflow over the past 98 years have caused formation of the Truckee River delta at Pyramid Lake (COE, 1995).

b. Groundwater

The configuration of the shallow aquifer (0 to 50-foot depth to water) in the Newlands Project area has changed since the introduction of large-scale water projects. In 1904, the table generally sloped away from the Carson River and Stillwater Slough. The aquifer was about 5 feet from ground surface near the river and slough and about 10 feet from the ground surface 1 to 2 miles from the river. From 1916 through 1928, an extensive drainage system was constructed to control the buildup of the shallow aquifer in the Newlands Project area by providing interception and discharge of groundwater to the valley sinks such as Carson Lake and Stillwater Marsh. Currently, there are about 350 miles of drains, 300 miles of irrigation laterals, and 68.5 miles of main canals. The depth to water is more uniform today—5 to 10 feet throughout much of the area—than it was in the past, a result of the continuing contribution from irrigation recharge and canal seepage. Seasonal fluctuation of 1 to 3 feet is common, depending on irrigation delivery, cropping pattern, water supply, and rainfall (USGS, 1993).

2. Water Quality

Surface water quality in the study area has diminished greatly since the mid-1800s, primarily as a result of population increases and industrial practices. Mining, lumbering, sawmills, livestock grazing, water projects, and even the 1960 Winter Olympics severely affected the quality of water in Lake Tahoe, the Truckee River, tributary streams, and Pyramid Lake.

Extensive logging and milling operations throughout the Sierra Nevada quickly and severely degraded the quality of the Truckee River and choked the rivers banks and bed with sawdust, even creating sawdust bars at the river’s terminus at Pyramid Lake, which proved impassable to fish attempting to spawn upstream. Moreover, flumes used to transport logs to the river were lubricated with tallow, dogfish oil, or rancid butter, much of which discharged to the river. Clearcutting of the forests in the basin to supply wood for mining timbers, railroad ties, and other development resulted in discharge of large amounts of sediment to the river, further degrading water quality (Nevada, 1997a).

Reno’s first sewer lines were built around 1868 and consisted of pipes connected with each storefront and then extended down alleys or streets to the Truckee River, where raw sewage poured directly into the river. During the summer when the stream channel frequently dried up, the area was rank with piles of untreated waste awaiting the fall rains to carry the piles away downstream. This condition existed well into the 1900s (Nevada, 1997a).

In 1880, Highland Reservoir began providing municipal and industrial water to the city of Reno. This open, unfiltered water system took water directly from the Truckee River by an open canal which was easily fouled by feedlots and decaying carcasses of range stock. Reno residents often complained that their municipal water “looks thick and nasty, and tastes and smells just as nasty as it looks, having the flavor of rotten wood, dead fish and general staleness” (Townley, 1983). Making matters even worse, a strainer at the reservoir outlet frequently came loose, admitting trout and other fish into the pipes, which, as the pipe diameters through the Reno water distribution network narrowed, subsequently turned them into infamous “Reno chowder” by the time they reached the kitchen sink (Nevada, 1997a).

In 1899, the Floriston Pulp and Paper Company, located at the present-day site of Floriston, California, began operations with the daily discharge of up to 150,000 gallons of acidic waste directly into the Truckee River. By 1903, the Truckee River's water quality had deteriorated to the point where it was reported that the water at the Virginia Street bridge in downtown Reno consisted of a "blend between black and brown with soapy bubbles covering the surface" (Reno Evening Gazette, October 14, 1903). Despite court ordered injunctions and the threat of a Nevada suit filed with the U.S. Supreme Court, discharges continued until late 1930 when the plant ceased operations (Nevada, 1997a).

In 1962, an 8-inch secchi disc and a hydrophotometer test revealed that the disc was discernible in Lake Tahoe at a depth of 136 feet and light was detectable at 500 feet. In 1969, the secchi disc was visible at only 100 feet, equating to an annual 4 percent reduction in clarity (Report of the Lake Tahoe Joint Study Committee, March 1967, and Houghton 1994). By the 1980s, the disc was discernible at a depth of 75 feet (California, 1991). In recent years, clarity has varied. In 2002, the average discernible depth was 78 feet (University of California, Davis, February 25, 2003).

To eliminate the effect of numerous wastewater discharges on the water quality of Lake Tahoe, the Tahoe-Truckee Sanitation Agency was formed in 1972 to create a regional entity for collecting and treating wastewater from communities located along the northern and western shore of Lake Tahoe; Alpine Meadows, Squaw Valley, and Northstar Ski Resorts; and the town of Truckee and its environs (TTSA, 1999). Nutrients and organics were diverted from Lake Tahoe, thus reducing algal growth and improving water clarity.

Tributaries contribute sediments to the Truckee River, particularly during flood events. For example, the Gray Creek watershed is characterized by extremely steep terrain, unstable soil conditions, extensive logging, and overgrazing by livestock. On many occasions, mud flows from Gray Creek have caused the Truckee River to "run red" through Reno. An investigation of the Gray Creek watershed by the U.S. Forest Service (USFS) showed that little could be done to alleviate this periodic flood-related problem due to topographical, hydrological, and biological conditions (Joplin and Fiore, 1995).

Studies performed in 1991 concluded that agricultural runoff along the lower Truckee River approximated nutrient input from the Reno-Sparks sewage treatment plant (COE, 1995).

The Truckee River Water Quality Settlement Agreement (WQSA), signed in October 1996, establishes a joint program to improve water quality by increasing seasonal streamflows in the Truckee River downstream from Truckee Meadows through the purchase and dedication of Truckee River water rights for streamflow. Water associated with the exercise of water rights acquired pursuant to WQSA would be stored, when possible, in Prosser Creek and Stampede Reservoirs, and would be managed by the parties acquiring water rights under WQSA and by the Pyramid Tribe.

3. Sedimentation and Erosion

a. Truckee River Basin

Extensive logging and mining in the 1800s led to erosion of hillsides, causing severe sedimentation in the Truckee River and destabilization of the natural geomorphology. By the late 1800s, more than 60 percent of the mature trees in the Lake Tahoe basin had been cut down, resulting in extensive erosion and sedimentation problems in the tributaries to Lake Tahoe, including the Truckee River in Nevada (Nevada, 1997a).

In 1886, the Reno Reduction Works, an ore processing plant, was established. The mill discharged rock residue into the Truckee River, leading to sediment deposition.

In the lower Truckee River, the Truckee Canal has had profound effects on sedimentation and geomorphology.   Pyramid Lake dropped more than 80 feet between 1905 and 1967, which caused a lowering of the base level of the Truckee River. Lowering the base level of the Truckee River resulted in greater sediment loads and an unstable channel downstream from Derby Diversion Dam. The high sediment loads greatly increased the size of the Truckee River delta, and the lowermost reaches of the river became incised. Sedimentation of the delta was so great that the cui-ui’s ability to cross the delta to access the river was greatly impeded. Marble Bluff Dam and Pyramid Lake Fishway are designed to reduce erosion along the lower Truckee River and to aid migration of Pyramid Lake fishes, respectively.

The construction of Boca Dam probably resulted in increased sedimentation and erosion on the Little Truckee River. Prosser Creek Dam, Stampede Dam, and Martis Creek Dam have greatly reduced floods on the Truckee River, which has resulted in decreased sedimentation and erosion. However, other factors have offset the benefits of these dams, including the large population increases in Reno and surrounding areas and urbanization, which results in increased runoff, channel degradation, and erosion.

COE stream channel work conducted in the Truckee River in the 1950s, including clearing and straightening, accelerated sedimentation and erosion in many reaches (COE, 1992). The greatest effects occurred in the reach between Wadsworth and Pyramid Lake, where straightening steepened the channel, causing it to be less resistant to high flows. As a result, a 1963 flood caused extensive flooding and erosion.

In 1974, to improve conveyance of Truckee River water in Reno and downstream, COE removed reefs near Vista (Nevada, 1997a), and several wetlands were drained in the eastern portion of Truckee Meadows, resulting in erosion in Steamboat Creek.

In 1992 and 1995, localized rainstorms on Gray Creek resulted in the discharge of extensive quantities of sediment to the Truckee River (Nevada, 1997a). Studies concluded that little could be done to control erosion in the watershed because of topographic, hydrologic, and geologic conditions.

Then in January 1997, a record peak flood flow, the result of a rain-on-snow event, occurred in the Lake Tahoe basin (Rowe et al., 1999). The water elevation of Lake Tahoe rose more than one foot, reaching its highest level since 1917, at elevation 6229.4 feet. The high water level, along with strong winds, resulted in extensive erosion and sedimentation at the lake and in the upper Lake Tahoe basin.

b. Carson River Basin

Development of the Newlands Project and diversion of Truckee River water through the Truckee Canal changed the geomorphology of the lower Carson River. The widely varying hydrologic regime instead became a regulated flow condition with hundreds of miles of irrigation channels.

In 1970, USGS sampled sites in the Carson River basin downstream from the Comstock era mines and identified elevated mercury concentrations in unfiltered river and sediment. High concentrations of mercury also were found in the sediments and fish of Lahontan Reservoir, downstream from the reservoir on the Carson River, and at Stillwater WMA (Nevada, 2003).

In 1990, the U.S. Environmental Protection Agency (EPA) listed the Carson River Mercury Site, which includes approximately 100 miles of the Carson River and Stillwater NWR, on its National Priority List under the Comprehensive Environmental Response, Compensation, and Liability Act (55 Federal Register [FR] 35502-35512, August 30, 1990). Research is ongoing, and minor cleanup of the area has occurred. By 1994, EPA identified that health risks were most evident from fish and wildlife and sediment throughout the Carson River basin, including Lahontan Reservoir, the active channel of the Carson River, Carson Sink, and Stillwater NWR (Nevada, 1997b).

In January 1997, a flood flow in the Carson River peaked at 22,300 cfs (measured at the Fort Churchill gauge). The river carried an estimated 200,000 tons of sediment and 1.5 tons of mercury, representing nearly 33 percent of the total sediment load and 30 percent of the total mercury load estimated to have passed the gauging station during the 9-month sampling period from January through September 1997 (Hoffman and Taylor, 1998).

4. Biological Resources

a. Pre-settlement Conditions

(1) Truckee River Basin

Before the mid-1800’s, many portions of the free-flowing Truckee River and its tributaries were bordered by marshes and stands of willows. Marshy lowlands covered the eastern third of Truckee Meadows, which was vegetated with thick stands of grasses, bulrushes, and cattails. A natural rock formation at Vista partially constricted river flow so that high water during the spring runoff inundated an extensive area. Wetlands with dense stands of willows bordered the river, and abundant cottonwoods grew on slightly higher ground (Nevada, 1997a). The river meandered through Truckee Meadows, and islands were covered with thick stands of willows, cottonwoods, currant, and wildflowers (McQuivey, 1996, as cited in Nevada, 1997a). The lower Truckee River had extensive groves of large cottonwoods forming dense thickets (Ridgway, 1877). Historically, 450 acres of palustrine emergent wetlands and 7,700 acres of riparian (both shrub and forest) vegetation occurred along the river downstream from Vista (COE, 1992) in bands up to 2,000 feet wide (COE, 1995).

The Truckee River teemed with fish. Large numbers of Lahontan cutthroat trout (LCT), a fish of “extraordinary size” (Fremont, 1845, as cited in Nevada, 1997a), traveled from Pyramid Lake to the tributaries of Lake Tahoe and Donner Lake to spawn (Gerstung, 1988; Nevada 1995). Cui-ui inhabited both Pyramid Lake and Winnemucca Lake and spawned in the Truckee River, likely hundreds of thousands, up to what is now Wadsworth (Buchanan and Coleman, 1987). Pyramid Lake reached an elevation as high as 3878 feet (Galat et al., 1981) and, in some years, the Truckee River flowed into adjacent Lake Winnemucca.

Bird life was also plentiful and diverse. In 1868, naturalist Robert Ridgway identified 107 species of birds along the Truckee River downstream from Wadsworth (Ammon, 2002a). Thousands of pelicans, gulls, ducks, geese, and other waterfowl used Pyramid Lake (McQuivey, 1996, as cited in Nevada, 1997a), and Lake Winnemucca supported large numbers of waterfowl as well. Duck Lake, located just south of Pyramid Lake, was at times literally covered with mallard, teal, and coots; snipe were found along the shore (McQuivey, 1996, as cited in Nevada, 1997a). Bald eagles nested at Pyramid Lake as late as 1866 (Alcorn, 1988) and at Lake Tahoe.

(2) Carson River Basin

Cottonwoods lined the banks of the Carson River where it entered Carson Lake. The river supported large populations of trout and other fish, and Carson Lake supported fish, mussels, and other aquatic life (Simpson, 1876, as cited in FWS, 1996). In 1862, a flood event changed the river course so that it flowed directly into Carson Sink, and Carson Lake shrank (Nevada, 1997b). The maximum size of the lake and adjacent marsh was about 38,000 acres, with an average of 27,000 acres. Stillwater Marsh and Carson Sink averaged about 120,000 acres.

An estimated 150,000 acres of wetland habitat existed in Carson Lake, Stillwater marshes, and other terminal wetlands in Lahontan Valley between 1845 and 1860 (Kerley et al., 1993). In the late 1800’s, Carson Sink was “half shallow lake, half tule swamp” and supported salt grass, sedges, and tules (Nevada, 1997b). There was an abundance of submergent vegetation, bulrush, sedges, and salt grass in Stillwater Marsh and Carson Sink. Freshwater clams and aquatic snails, fish, mink, and river otter were present and used by the native people. Frogs, muskrats, pelicans, curlews, other shorebirds, ducks, geese, and other aquatic birds were abundant (Kerley et al, 1993).

b. Settlement Conditions

Since the 1850s, the Truckee and Carson River basins have been affected by a multitude of competing interests. Man has actively sought and exploited resources in the area—timber, ore, land, water, wildlife, and scenery. The following narrative highlights past cumulative effects that have led to conditions that exist today. Changes associated with lakes and reservoirs and changes along the rivers and streams of the study area are discussed.

(1) Lakes and Reservoirs

(a) Lake Tahoe and Truckee River Basins

With the arrival of settlers in the Truckee River basin, aquatic, wetland, and riparian communities began to change. Reconstruction of dams at Lake Tahoe (1913), Donner Lake (1930s), and Independence Lake (1939) created more aquatic habitat but reduced upland and riparian vegetation adjacent to the natural shoreline (by approximately 1,865 acres at Tahoe, 155 acres at Donner Lake, and more than 50 acres at Independence Lake). These and earlier dams created migration barriers for fish, and operations changed river flow patterns with far-reaching consequences. Loss of riparian vegetation by inundation likely reduced bird and small mammal populations. Inundation of Tahoe yellow cress habitat and impacts from recreation and development resulted in listing of the plant by the State of California in 1982 as endangered and by the State of Nevada as critically endangered. Human disturbance, including timber harvesting and development at and near the lakes, cumulatively have had far-reaching adverse effects on forest and riparian vegetation and associated wildlife.

Construction of Boca (1937), Prosser Creek (1962), Stampede (1970), and Martis Creek (1971) Dams and associated reservoirs further altered the environment, creating additional aquatic habitat at the expense of terrestrial valleys and their associated riparian and stream ecosystems. Losses at the reservoirs were approximately 980 acres of Jeffrey pine forest, sagebrush, and willow/aspen/meadow riparian habitats and about 4.7 miles of stream for Boca Reservoir; 3,450 acres of Jeffrey and lodgepole pine forest, sagebrush, and willow/meadow riparian habitats, 8.7 miles of streams and sloughs of the Little Truckee River, 3.7 miles of Sagehen Creek, and 7.6 miles of tributaries to the Little Truckee River for Stampede Reservoir; 750 acres of sagebrush and riparian habitats, 4 miles of Prosser Creek, 2 miles of Alder Creek, and 1.6 miles of tributaries to Prosser Creek for Prosser Reservoir; and several miles of stream and riparian habitats for Martis Creek Reservoir.

The valleys had historically provided biologically rich areas for riverine and terrestrial wildlife and were likely important movement corridors. Construction of the reservoirs likely adversely affected amphibians, many species of migratory songbirds, waterfowl, water shrews, Sierra Nevada mountain beaver, muskrat, mink, and otter. Although some of these species may use the reservoirs to a limited extent, the reservoirs do not provide quality habitat. Some reservoirs have likely increased habitat for some species of spring and fall migrating waterfowl.

Construction of the reservoirs resulted in a shift in composition of fish communities from river- to lake-oriented. Resource agencies have stocked and continue to stock non-native fish in lakes and reservoirs for recreational fishing in response to depleted native fish populations. In 1887, the first (recorded) Mackinaw (lake) trout (non-native) was introduced into Lake Tahoe (Nevada, 1997a). A non-native invertebrate (*Mysis relictus*) also was stocked in Lake Tahoe from 1963 to 1965 to enhance the prey base for lake trout. These introductions have likely disrupted native communities and increased predation on native fishes, amphibians, and macroinvertebrates (Goldman et al., 1979; Frantz and Cordone, 1970; Panik and Barrett, 1994; Knapp, 1994).

The noxious weed, Eurasian watermilfoil, has become established in shallow waters of Lake Tahoe. This species can form thick underwater stands and dense mats near the water surface (University of Nevada, Reno, no date). It crowds out native plants and modifies aquatic ecosystems. The non-native common mullein has invaded the drawdown areas of several local reservoirs, particularly Stampede Reservoir, and may provide a source of seed to spread to other areas.

Timber harvesting during the Comstock era and, more recently, pesticide use likely have contributed to a decline in raptor populations, particularly osprey, peregrine falcon, and bald eagle, around the lakes. Bald eagles and osprey have recently re-established territories at some of the reservoirs. A self-sustaining population of kokanee (non-native fish) provides a winter food source for bald eagles at Lake Tahoe.

Marinas, residential areas, boat docks, trails, and roads have directly reduced riparian habitat and wetlands around the lakes and reservoirs. In particular, construction of Tahoe Keys Marina reduced the largest Lake Tahoe wetland from an estimated 1,350 acres to approximately 500 acres. This impact likely reduced populations of muskrat; fish; yellow-headed, red-winged, and Brewers blackbirds and other songbirds; rails; and waterfowl. Use of these facilities has increased water consumption, disturbed wildlife, created nonpoint source pollution, and contributed to air pollution (which may degrade water quality).

Cui-ui was listed as endangered in 1967 under a predecessor to the current Endangered Species Act. The lowering of Pyramid Lake's elevation impeded access to the Truckee River, and flows frequently did not provide suitable conditions for cui-ui spawning and incubation. The original strain of LCT in Pyramid Lake became extirpated by 1944 (FWS, 1995b), due in part to overfishing and pollution, but primarily due to barriers to migration. A different strain of LCT was introduced to the lake in 1950, but dams and weirs prevented migration and lack of habitat in the lower river precluded spawning. Impacts to LCT throughout its range led to its being listed as an endangered species in 1970 (35 FR 13520, August 25, 1970), with reclassification as a threatened species in 1975(40 FR 29863, July 16, 1975). As stated previously, a fish lock at Marble Bluff Dam aids in river access for cui-ui and LCT during their annual spawning migration from Pyramid Lake. Marble Bluff Dam also routes streamflow through the Pyramid Lake Fishway; the fishway provides river access for cui-ui and LCT.

The initial recovery plan for cui-ui was written in 1978; since then there have been three revisions, most recently in 1992. A recovery plan for LCT was written in 1995. Both plans specify recovery criteria for the species and objectives designed to protect them, with the ultimate objective of delisting. In 1982, the U.S. District Court for the District of Nevada ruled that the Secretary must utilize all Project Water stored in Stampede Reservoir for the benefit of the Pyramid Lake fishes until the cui-ui and Lahontan cutthroat trout are no longer threatened or endangered, or until sufficient water for their conservation becomes available from other sources.

Changes to Pyramid Lake have affected other species as well. Several species of aquatic snail in Pyramid Lake have become extinct (LaRivers, 1962). Furthermore, salinity of the lake increased 32 percent between 1933 and 1980; high salinity may substantially reduce species diversity of the crustacean zooplankton community (Galat and Robinson, 1983). Increased flows to the lake in the past few years, however, have reduced salinity levels (Scoppettone, 1999).

The Truckee River delta at Pyramid Lake currently provides some habitat for shorebirds and waterfowl; the lake may have historically supported much larger populations. Winnemucca and Duck Lakes, which supported large waterbird and shorebird populations in the early 20th century, have dried up (Nevada, 1997a).

Adverse cumulative impacts have led to an increased awareness by the public and government agencies of the value of these ecosystems and to programs to restore them. This culminated in the President, at the Lake Tahoe Presidential Forum in 1997, directing his Administration to begin acting on recommendations to improve water quality of Lake Tahoe and restore forest ecosystems. These projects have begun through development and implementation of the Lake Tahoe Environmental Improvement Program (EIP), and include such activities as stream restoration, erosion control, prescribed burns, and retention of large conifers to restore old growth forest or healthy forest characteristics. See Chapter 4, “Cumulative Effects,” for future projects under the Lake Tahoe EIP. Forest restoration actions benefit the Truckee River and associated lakes and reservoirs by reducing the potential for catastrophic fire that could indirectly increase discharge of sediment to water bodies.

(b) Carson River Basin

Construction of the Newlands Project altered the natural hydrologic regime in Lahontan Valley, especially the wetlands (FWS, 1995a). Lahontan Reservoir inundated approximately 14,800 acres of sagebrush, saltbrush scrub, cottonwood forest, willow riparian, and marsh habitats, as well as approximately 12 miles of the Carson River. Nesting habitat for herons, egrets, and songbirds, and habitat for other riparian species that existed along the Carson River were inundated.

Islands in Lahontan Reservoir have provided nesting habitat for colonial nesting birds, including California and ring-billed gulls; reservoirs also attracted fish-eating birds such as terns, gulls, and pelicans which do not typically forage in riverine environments. Lahontan Reservoir has been used extensively during waterfowl migrations (Saake, 1994).

(2) Rivers and Tributaries

(a) Truckee River Basin

Dams at Lake Tahoe, Donner Lake, Independence Lake, and on the Little Truckee River, Prosser Creek, and Martis Creek have altered streamflows and flow patterns in the Truckee River and its tributaries.

Some of the greatest effects of dams have been incision of the river channel, narrowing of the flood plain, destabilization of riverbanks, loss of riparian vegetation and wildlife, interruption of migration corridors for spawning native fish, changes in the flow regime, and streamflows inadequate to support native invertebrates and fish. Fish can be trapped and killed by unscreened diversions. Movement of sediment also has been interrupted by dams. Sediment is important in the formation of gravel bars, which are highly productive invertebrate areas and provide habitat for fish spawning and egg incubation. Vegetative growth on point bars helps to narrow and deepen the stream channel, thereby providing cooler water and improving fish habitat.

In 1998, the Nevada State Engineer approved applications by the Pyramid Tribe to appropriate a maximum of 6,000 cfs of unappropriated water of the Truckee River and its tributaries, in part for spawning and conservation of cui-ui and LCT. This water has benefits for other aquatic life as well.

As discussed under "Water Quality," mining, logging and sawmill operations, and other practices in the late 19th century led to severe degradation of water quality in the study area. Currently, streamflow reductions and alterations, loss of riparian vegetation that shaded the river, discharge of treated sewage effluent, and agricultural runoff promote degraded water quality and increased water temperature in the Truckee River. High seasonal water temperatures in the lower river preclude LCT and other salmonid species and, during summer months, often increase fish mortality. Invertebrate prey species for trout (mayflies, caddisflies, and stoneflies), which are indicators of good water quality, generally decline in the lower reaches of the Truckee River during many years.

Construction of Interstate 80 along the river corridor (1953 to 1979); construction of the Central Pacific Railroad in the 1860s, and later straightening of the corridor by Southern Pacific Railroad; urban development in Truckee, Reno, and Sparks; livestock grazing; construction of bridges; sand and gravel mining; river channel modification by COE for flood control in the 1960s; and clearing of vegetation cumulatively have had adverse effects. These actions eliminated many of the natural meanders of the Truckee River, altered sediment loads that provided fish spawning gravels, eliminated oxbows and wetlands, reduced periodic flooding of wetland vegetation, restricted channel migration, and eliminated an extensive riparian area.

By 1992, approximately 390 acres of palustrine emergent wetlands and 6,680 acres of riparian (both shrub and forest) vegetation that historically occurred along the Truckee River downstream from Vista had been eliminated, a result of clearing for agricultural and urban use, and cutting for firewood. Only about 60 acres of wetland and 1,020 acres of riparian vegetation remain (COE, 1992). Water management altered streamflow patterns to the degree that cottonwood regeneration was all but precluded (COE, 1995). The presence of beaver, thought to have been introduced to the Truckee River basin by USFS in the early 20th century to control erosion at the headwaters (Hall, 1960), and livestock have further reduced cottonwood survival in some areas.

In the early 1980s, FWS began to develop and implement a flow management strategy for the lower Truckee River to benefit cui-ui recovery. That strategy utilized a flow regime (and related selection criteria) to supplement unappropriated water in the lower river with project water in Stampede and Prosser Creek Reservoirs to “maximize occurrence of suitable river stages and lake conditions during spawning runs.” Generally, in years when sufficient water was forecast to be available to promote cui-ui spawning and recruitment, project water would be released as necessary during April through June to assist in achieving prescribed flows. An evaluation tool (“cui-ui model”) was developed to be used in conjunction with the Truckee River Operations Model to evaluate the relative benefits to the cui-ui population of various water management scenarios for the Truckee River basin. The cui-ui model provided the analytical basis for cui-ui in the 1998 draft environmental impact statement/ environmental impact report (DEIS/EIR). FWS has since replaced the cui-ui flow regime, which was a single-species strategy, with an expanded set of flow regimes that is intended to broaden the use of project water and other dedicated waters to provide recovery benefits for both cui-ui and LCT and the riverine habitat upon which they depend.

Water diversions, poor water quality, overfishing, and the loss of wetlands and the cottonwood riparian forest are major factors that have affected native fish and wildlife. In the 1860s, both settlers and Indians were fishing on the Truckee River and at Lake Tahoe for profit and recreation. Immense numbers of LCT were caught and shipped to San Francisco and mining camps (Sigler and Sigler, 1987). Later, canning plants were constructed along the river to process the fish. Between 1873 and 1922, up to 100 tons of LCT were harvested annually from Pyramid Lake and the Truckee River (Townley, 1980, as cited in Nevada, 1997a). Weirs and dams constructed in the river restricted LCT and cui-ui from reaching spawning grounds and facilitated harvest.

In the latter half of the 19th century, the large amounts of sawdust and debris from upstream lumber mills that created the delta at the terminus of the Truckee River further restricted these spawning migrations and contributed to the decline of the LCT population. Construction of the Newlands Project in 1905, which created an additional barrier at Derby Diversion Dam and diverted water from the river to the Lahontan Valley via the Truckee Canal, resulted in an eventual decline of Pyramid Lake.

Rainbow trout were first stocked in the river in California in 1879, brown trout in 1941, and kokanee in 1951. Catfish, rainbow trout, and brook trout were introduced to the Truckee River in Nevada in the 1870s and 1880s and, after 1890, the Truckee River was stocked annually to satisfy the demand of sport fishing (Nevada, 1997a).

A 1972-76 bird study along the lower Truckee River (Klebenow and Oakleaf, 1984) showed that 42 of the 107 species identified by Ridgway in 1877 were not present. A 1992-93 survey rarely detected marsh wren, savanna sparrow, or common yellowthroat, and American bittern and sora were not observed at all (Morrison, 1992a; 1993). Surveys in 1998 found 80 species, but some were non-native and others were not present in Ridgway's time. The net species loss between 1868 and 1998 was 47 percent, and several important habitat types were no longer present or were underrepresented (Ammon, 2002a). Declines in species diversity and abundance had occurred and are probably occurring in the amphibian (Panik and Barrett, 1994) and mammalian communities as well. However, as the result of cottonwood regeneration following favorable conditions in 1983 and 1987, and since restoration of cottonwoods along the lower river was begun in 1995, populations of some species of birds have substantially increased in abundance (Rood et al., 2003).

A major factor that has influenced native fish and wildlife communities is introduction of exotic species (including tamarisk, broad-leaved peppergrass, whitetop, purple loosestrife, Russian thistle, bullfrogs, non-native fishes, and several aquatic invertebrates). Non-native trout and bullfrogs consume young of native fishes and amphibians. Whitetop has overrun native habitats and currently is believed to cover about 12,000 acres along the Truckee River and its tributaries (Donaldson, 1999). Purple loosestrife has been found along approximately 49 miles of the Truckee River downstream from Reno (O'Brien, 1999). Eradication programs are currently being implemented to eliminate whitetop and purple loosestrife. Eurasian water milfoil has been found along 9 miles of the Truckee River downstream from Lake Tahoe and in a pond at Verdi (Donaldson, 1999).

In recent years, attention has focused on enhancing streamflows in the Truckee River, which directly or indirectly would benefit fish and other aquatic life. In 1995, FWS expanded its cooperative effort with the Federal Water Master to manage reservoir releases to promote establishment of cottonwoods along the river, particularly downstream from Derby Diversion Dam. The effort has been successful, and millions of cottonwood seedlings have become established along the lower river (Rood et al., 2003). In 1996, the Truckee River Water Quality Settlement Agreement was signed, which will increase seasonal streamflows in the river and, secondarily, will improve habitat for aquatic life. Also see "Water Quality." Other actions designed to improve conditions for fish have been implemented, including the fish lock at Marble Bluff Fish Facility, which can pass 800,000 cui-ui during a spawning run.

Other efforts include those of The Nature Conservancy to restore reaches of the Truckee River downstream from Vista and the Truckee River Watershed Council, which is assisting others in acquiring funds for restoration projects along the Truckee River and tributaries in California. These ongoing efforts are described in more detail in chapter 4.

Currently, the Pyramid Tribe is implementing a management plan that includes water quality monitoring in the Truckee River, riparian restoration measures along the lower river, and several measures from the Cui-ui Recovery Plan. It has implemented a fencing program to reduce streambank damage from livestock and improve cottonwood regeneration between Wadsworth and Pyramid Lake.

(b) Carson River Basin

During the Comstock era, milling operations in the Virginia Mountain Range and along the Carson River used mercury to process gold and silver ore. As much as 7,500 tons of elemental mercury may have been discarded in mill tailings or discharged to the Carson River or its tributaries (Bailey and Phoenix, 1944). This mercury flushed downstream; mercury has been found in sediment, water, and fish in Lahontan Reservoir, Carson Sink, and Stillwater NWR. (See “Sedimentation and Erosion.”)

Diversion of Carson River water for agriculture reduced and modified the pattern of flow available to Lahontan Valley wetlands; this resulted in drying of marshes at Stillwater NWR, Carson Lake, and Carson Sink (Kelly and Hattori, 1985; Morrison, 1964; Townley, 1977, all as cited in FWS, 1996). Kerley et al. (1993) described changes in local wetland conditions, as summarized here. Wetland acreage in Lahontan Valley has been 10 percent of that documented in 1905. From 1967 to 1986, Carson Lake wetlands averaged 10,000 acres, and Stillwater Marsh wetlands averaged 14,000 acres. During the drought of 1987-1994, wetland acreage dropped to a low of about 2,400 acres (FWS, 1995a). Following the drought, the baseline wetland habitat in Lahontan Valley totaled about 16,600 acres in 1995 and 59,000 acres in 1997 (Henry, 1999).

Since construction of the Newlands Project, wetlands have been partially maintained with drainwater, which can contain contaminants. Sediments from some wetlands contained elevated concentrations of arsenic, lithium, mercury, molybdenum, and zinc. Biological tissues from some wetlands also contained elevated concentrations of materials associated with adverse biological effects on wildlife, particularly migratory birds. In most years, the water discharges were too low to flush these accumulated substances from the wetlands (FWS, 1996). TCID currently operates Lahontan Reservoir with flood flow criteria, and spills and precautionary drawdowns are directed first to wetlands and then to farmland.

Section 206 of P.L. 101-618 authorizes the acquisition of water and water rights for wetlands in Lahontan Valley. In 1990, FWS initiated a series of programs to acquire from willing sellers up to 75,000 acre-feet from the Carson Division and 50,000 acre-feet of additional water from segment 7 of the Carson River, reservoir spills, drainwater, and other sources. As of June 2003, 32,800 acre-feet had been purchased in the Carson Division, 4,300 acre-feet from segment 7 of the Carson River, and 2,900 acre-feet from the Navy. Most purchases have occurred at the edges of the Newlands Project near Stillwater NWR and Carson Lake (Grimes, 2003).

FWS has developed a comprehensive plan to manage Stillwater NWR that focuses on approximating natural habitat conditions as the primary means to conserve and manage refuge wildlife, restore natural biological diversity, and fulfill international treaty obligations with respect to fish and wildlife. The boundary of the refuge would be expanded to include a majority of the lands now within Stillwater WMA and portions of Fallon NWR, as well as land along the lower Carson River and other lands north of the existing refuge (FWS, 2003).

The expansion of agriculture in the valley, made possible by the Newlands Project, has eliminated approximately 74,500 acres of desert salt bush scrub, riparian, and wetland communities, which provided habitat for wildlife, and replaced it with fields of alfalfa and other crops. Agricultural fields provide foraging habitat for some wildlife, however, such as white-faced ibis. Residential housing, subdivisions, and commercial and industrial development have increased in Lahontan Valley in recent years. These developments have eliminated agricultural and wild land, including wetlands and riparian areas, thereby reducing habitat used by wildlife. Fallon NWR (1931), Stillwater WMA (1948), and Stillwater NWR (1991) were established for wildlife in the area.

5. Socio-Economic Environment

Before 1850, the primary economic activities in the Truckee River basin were concentrated in trading posts and stop-off stations for travelers moving west to California and Oregon, although some ranching and farming also occurred. Two events that brought about significant economic development in the area were the discovery of Comstock Lode in 1858 and the development of the intercontinental railroad in the 1860s. These events attracted workers, miners, and entrepreneurs into the area. With the development of mining and the railroad, the demand for lumber and agricultural products greatly increased, which accelerated the growth in the lumber mill and agricultural sectors in the regional economy from 1860 to 1880.

Alfalfa seed, also known as “Chili clover,” was introduced to Truckee Meadows agriculture in 1868. Farmers soon planted it extensively, as it tolerates salt, variable climate, drought, and insects. By the mid-1870’s, it was the staple crop.

When the Comstock fortunes began to fade in the early 1880s, a 20-year depression in Nevada began. Although this depression eventually caused the State’s population to fall by 32 percent, from 62,226 in 1880 to 42,355 by 1900 (Nevada, 1997a), the railroad and agriculture fostered development in Truckee Meadows.

From 1890 to 1920, the demand for agricultural goods increased. To help meet this increased demand, the Newlands Project was constructed to provide additional water for irrigation in Lahontan Valley.

During the 1890s, Floriston Pulp and Paper Company, Truckee River General Electric Company, Washoe Power and Development Company, and Reno Power, Light and

Water Company, were taking water from the Truckee River to produce the newly popular electrical energy (Townley, 1977). It was also around this time that tourism trade began to grow in the Lake Tahoe area. (See “Recreation.”)

During the Depression years, gambling was legalized in Nevada, which helped to sustain the local economy. In the latter part of the 1930s, Federal legislation was approved for the development of additional water storage under the Truckee Storage Project.

During World War II, there was considerable economic growth due to the development of military installations, such as a pilot training station near Fallon and a munitions depot near Hawthorne.

The regional economy grew during the 1950s and 1960s, primarily in the mining, gambling, and tourism industries. In the 1970s and 1980s, the tourism grew rapidly, particularly as a result of growth in the ski resort industry in California and further development of gambling in Nevada near Lake Tahoe. This economic growth has led to additional real estate development in the area, particularly in the vacation-home market.

From 1980 to the present, economic trends in the river basin again have been dominated by growth in recreation, tourism, and gambling, as well as growth in the transportation/ warehouse sectors. At the same time, irrigated agriculture production in Truckee Meadows, as well as in the Newlands Project, has decreased.

6. Recreation

Settlers brought their cultural institutions and their need for services, including recreation, which expanded through time. From the time of John Fremont to the present, many factors have contributed to the enhancement and enjoyment of the recreation resources of the study area. The natural beauty of the high Sierra Nevada, with its alpine forests and natural fresh water lakes such as Lake Tahoe, Donner Lake, and Independence Lake, has attracted tourists for more than a hundred years. Construction of roads and railroads into the high country provided improved access, thereby increasing recreational opportunities. Construction of Prosser Creek, Stampede, Boca, and Lahontan Reservoirs to benefit farming/ranching indirectly benefited recreation by providing additional opportunities to picnic, swim, camp, hunt, and fish. Over time, the establishment of city, county, and State parks and private resort development, as well as the incorporation of land into the Federal estate, has enhanced recreation opportunities in the area.

a. Recreational Fishing

While in the Truckee River basin, Fremont benefited from the hospitality of the Paiute Indians by feeding on the “incredibly large” species of LCT, some weighing more than 40 pounds, which was plentiful in Pyramid Lake and the Truckee River (Nevada, 1997a). Although the fish were primarily a source of food for the Paiutes and early settlers and later as a commercial source for both, it can be assumed that because of their size and abundance, they also provided a recreational fishery. California's efforts to maintain the LCT fishery in the Truckee River is well documented.

Settlement in the Truckee-Donner area began in the 1860s, based primarily on logging and railroad construction and operations. Silt loading from timber clearcutting and resultant hillside runoff degraded river water quality and affected native wildlife. It can be assumed that the quality of the recreational fishery declined as the quality of the Truckee River environment declined.

In 1875, because of depleted stocks of native fish in the Truckee River, the California Fish Commission released the first non-native fish species into the Truckee River upstream of the confluence of the Little Truckee River (Nevada, 1997a). The disappearance of LCT upstream of Verdi, Nevada, was recorded in 1880. The California Fish Commission filled the void with McCloud River rainbow trout, Eastern brook trout, and other non-native trout. In early 1880, a fisherman reported an occasional "keeper" (Townley, 1980).

After 1890, game fish were stocked in the Truckee River annually to meet the demands of sport fishing. Nevada's restocking stressed the McCloud River trout and brook trout. Restocking was assisted by the Virginia & Gold Hill Water Company, which annually contributed over 250,000 fry from its Marlette Lake fish hatchery (Nevada, 1997a).

Between 1938 and 1944, the Pyramid Lake strain of LCT in Pyramid Lake was extirpated through a combination of physical impediment to upstream spawning runs, river pollution, sawdust covering spawning gravel, and overfishing (Nevada, 1997a).

Today, fishery management in the region is characterized by a proliferation of public/private/tribal partnerships. In recent years, voters have passed State and county bonds for the outdoors, including the Truckee River. Community-based planning and funding efforts have been focusing on developing the Truckee River within vegetated banks and wetlands rather than concrete and rock lined channels. Unneeded bridge abutments are being removed, old oxbows are being reclaimed, and trees are being planted. Within the river, boulders are being placed with the objective of restoring the river to a more wild condition, which will also provide better habitat for fish and opportunities for anglers.

Restoration efforts could have the effect of returning the Truckee River to a first-class fishing river. The Pyramid Tribe has an extensive fishery program that includes partnerships with Nevada Department of Wildlife (NDOW) and FWS.

b. Tourism and Recreation

Tourism and recreation in the Sierra Nevada always has depended on access. Construction of the transcontinental Central Pacific Railroad in 1868 led to the founding of Truckee, California, and provided a gateway to Lake Tahoe and the surrounding area.

Lake Tahoe's tourism expanded when the Bliss enterprise formed a new corporation, the Lake Tahoe Railway and Transportation Company, obtained a franchise, and in 1889 began construction on a narrow gauge railroad between Tahoe and Truckee. Service was offered three times a day during the summer, and the train and the climb were marvels. With the completion of the railroad, a 170-foot luxury excursion steamer, the Tahoe, was added in 1896. The Bliss corporation then built Tahoe Tavern, for many years a world famous hotel (Hinkle and Hinkle, 1987).

By the dawn of the 20th century, the extensive logging operations at Lake Tahoe had passed out in favor of an economy based on tourism and recreation. In 1931, gaming became legal in Nevada and a new industry was born.

In 1960, Lake Tahoe was given greater visibility when the Winter Olympics were held at Squaw Valley. The Winter Olympics elevated the importance of winter sports in the area to an international level, thus guaranteeing a steady stream of tourists.

Construction of dams and reservoirs between 1929 and 1970 and the subsequent development of associated facilities over time supplemented the recreation opportunities already existing at the many natural lakes in the study area. Demand for recreation in the Truckee area spawned the creation of the Truckee Donner Recreation and Parks District in 1962. Several of the recreation facilities adjacent to Donner Lake are managed by the District in cooperation with California State Parks. Most of the other recreation facilities associated with lakes and reservoirs are managed by USFS cooperating with many other governmental and private entities.

The Truckee River was not embraced by nearby residents, municipalities, and county governments as a recreational resource for the region until the 1970s and 80s. Since that time, a recreational river corridor was conceived, improvements to the river corridor have been made, and many recreational enhancements such as access facilities have been built (Resource Concepts, Inc., 2002).

The January 1997 flood provides an indication of a newly developed respect of the Truckee River as a recreational amenity. COE proposed rebuilding the flood walls that lined the Truckee River, but a task force of residents convened by local governments persuaded COE to rethink past flood control measures. With a sales tax to fund the community's share of the project, the task force developed a plan that would return the river to a more natural state and provide flood protection while enhancing river based recreation (Reno Gazette Journal, 2003). The future of river recreation on the Truckee River can be characterized as being based on private public partnerships and support for restoration, environmental enhancement, and recreational projects.

7. Cultural Resources

Human cultural resources are often transitory. Successive cultures that used similar resources often settled in and used the same locations as those they followed. The result is that remains of earlier settlements were displaced or destroyed, or the context of materials of a particular period lost. The more intensive the settlement or use of the land, the greater the probability of loss of these earlier sites.

Reservoir construction inundated most sites and, in some cases, subjected shoreline sites to wave action, destroying any evidence or context. As transportation infrastructures and economic bases expanded, humans built many cities and towns over previous settlements. Such development and the subsequent increases in human land use can also contribute to site erosion or unauthorized collecting. Large-scale construction and ground disturbance activities associated with mining, logging, and ranching altered the natural environment and earlier sites. Some sites were more ephemeral than camps; many were located in areas of extensive timbering or grazing. Therefore, some sites may have been compromised due to extensive resource consumption by humans and animals alike.

GENERAL METHODS AND ASSUMPTIONS

This section provides an overview of the general methods and assumptions used to evaluate potential effects on study area resources under current conditions, the No Action Alternative (No Action), Local Water Supply Alternative (LWSA), and Truckee River Operating Agreement Alternative (TROA). Specific methods of analysis are presented in the discussions of the effects of the alternatives on individual resources.

I. Comparative Evaluation of Alternatives

In compliance with the National Environmental Policy Act of 1969 (NEPA), this EIS/EIR compares the potential effects (beneficial and adverse) on study area resources under the two action alternatives (LWSA and TROA) to No Action. Additionally, in compliance with the California Environmental Quality Act (CEQA), this EIS/EIR also compares the potential effects on resources under the alternatives (No Action, LWSA, and TROA) to the existing environmental setting, or “current conditions” as referred to in this document. Thus, the potential effects on study area resources under No Action are compared to current conditions, and the potential effects on resources under the action alternatives are compared both to No Action and current conditions.

Under NEPA, mitigation is not required for any adverse effects that may occur under No Action, but may be considered for adverse effects that may occur under the action alternatives. As under NEPA, mitigation is not required under CEQA for any adverse effects that may occur under No Action; however, section 15126.4(a) of the CEQA Guidelines requires a discussion of feasible measures to avoid or substantially reduce significant adverse effects that may occur with the proposed action.

Because resources in the study area are numerous and complex, potential effects on some resources were analyzed using representative indicators selected by the analysts. For example, rather than analyzing all fish populations, certain species were selected to provide a focused analysis of the effects of the alternatives.

For this study, the Truckee River Operations Model (operations model) was used to simulate water management and demands in the Lake Tahoe, Truckee River, and lower Carson River basins. Analysts used simulated hydrologic (i.e., water) results generated by the operations model to identify potential hydrologic differences among current conditions and the alternatives, including No Action. On the basis of these hydrologic differences, analysts then analyzed and compared the potential effects of the alternatives on water and water-related resources in the study area. Computer models such as the operations model are commonly used to simulate operations of a river system, particularly when numerous complex and repetitive tasks must be performed, and they are often used in environmental studies such as this EIS/EIR.

II. Truckee River Operations Model

The Truckee River Operations Model (operations model) is a mass-balance accounting model that adds and subtracts simulated water from the Lake Tahoe, Truckee River, and lower Carson River basins on a monthly basis to calculate stream flows and reservoir storage at specified locations over a specified period of time (in this instance, 100 years). Additions include unregulated runoff, reservoir inflows and releases, tributary inflows, return flows, and effluent return; subtractions include evaporation, diversions, canal losses, and Farad-Derby depletions. Using prescribed water management practices and water demands, the operations model tracks unregulated runoff as it is captured in reservoirs or flows freely in the river. It calculates monthly changes in reservoir storage; reductions attributable to evaporation, spill, and diversion for agriculture and M&I use; and return flows from diversions. These parameters are identified in "Surface Water," in individual sections entitled "Method of Analysis and Operations Model Input."

The operations model was used to simulate water management when the proposed action would be fully implemented. (See "Use of Operations Model in EIS/EIR" and "Study Assumptions" in this section.) Although community planners can forecast future demand for water with some degree of confidence, meteorologists cannot make long-range water resource (i.e., runoff) forecasts with the precision needed to compare the alternatives. It is standard practice, however, for hydrologic models to use the historic record in comparative analysis that simulates future conditions. Using historic runoff data as input, the operations model can simulate the effects each alternative would have had on historic water supplies and related resources on the assumption that future conditions will resemble those of the past. Because runoff data for a particular water year cannot represent long-term environmental conditions when the proposed action would be fully implemented, runoff data for water years 1901–2000 were used so that the alternatives could be analyzed under a range of hydrologic conditions. By holding water demands constant at the future level and assuming that all existing water management facilities are in place, analysis of the alternatives based on operations model results can focus on the variability of water management rather than weather. Because of the long hydrologic record for input, simulations from the operations model produce long-term averages, extremes, and variability that can be useful in making quantitative comparisons among alternatives to determine which best satisfy criteria of interest for water and related resources.

A. Development of Operations Model

In the 1970s, Reclamation initiated development of a computer model as a planning tool to simulate water management and demands within the Truckee River and lower Carson River basins. The computer model was developed to simulate approximate average monthly water yields in response to varying water management practices, not to simulate historic flows. Before 1975, Reclamation staff in Carson City, Nevada, and Denver, Colorado, developed the initial computer model (model) for simulating the complex water management of the Truckee-Carson River system. The computer program and basic data inputs for the model have been continuously refined and updated since 1975.

In the early 1980s, the model used 80 years of runoff data (water years 1901–1980) at key points in the river system to simulate hydrologic conditions under a variety of water management practices. These databases were composed mainly of historical records, but where no historical records existed, runoff data were estimated using correlations to known flows, precipitation-runoff relations, and, when necessary, professional judgment. Though there is no single source of documentation for the model and input databases, documentation exists in the form of informal notes, memoranda by various parties, portions of summaries and analysis of specific simulations, and the collective memory of staffs of the various entities involved in the development of the operations model.

In the mid-1980s, a Technical Advisory Committee (TAC), consisting of representatives of Sierra Pacific, Pyramid Tribe, TCID, State of Nevada, Reclamation, and FWS, was formed to guide the development of the database and revisions to the model. TAC recommended development of a single version of the model that was agreeable to all parties to evaluate OCAP for the Newlands Project, which governs diversion of Truckee River water at Derby Diversion Dam. Reclamation used this version of the model to evaluate alternatives in the Newlands Project Proposed Operating Criteria and Procedures EIS (Reclamation, 1987). Westpac Utilities (a subsidiary of Sierra Pacific) also used it for its 1985 Water Resource Plan studies.

In 1988, consultants to Sierra Pacific modified the model to segregate monthly hydrologic data for Martis Creek Reservoir, Donner Lake, Independence Lake, and Hunter Creek and to describe the relations between water uses along the Truckee River and depletion/accretion of Truckee River flows between the State line and Derby Diversion Dam. The consultants also incorporated various optional operations criteria for the purpose of analyzing water management alternatives (e.g., storage and release of Credit Water) proposed during the negotiation of the 1989 Preliminary Settlement Agreement between Sierra Pacific and the Pyramid Tribe, as modified by the Ratification Agreement by the United States (PSA). In 1994, Sierra Hydrotech, through a Reclamation contract, updated the historic hydrologic data set for water years 1981–1992 and added (1) variable streamflow targets for water quality and fish and wildlife enhancement at specific locations and (2) reservoir storage targets. This version of the model is referred to as the Negotiations Settlement model. A separate model (known as Below Lahontan Reservoir model) was developed to use Lahontan Reservoir release output data from the Negotiations Settlement model to simulate water deliveries to the individual districts of the Carson Division of the Newlands Project and to Lahontan Valley wetlands. FWS used the results of that model in preparing the Water Rights Acquisition Program for Lahontan Valley Wetlands EIS (FWS, 1996).

In 1998, in support of TROA negotiations, Sierra Hydrotech modified the Negotiations Settlement model to facilitate evaluation of water management alternatives. Modifications included updating the historic hydrologic database by adding water years 1993–97 as well as adding Newlands Project and city of Fernley Credit Water operations, 1997 OCAP operations, and Truckee River Water Quality Settlement Agreement provisions. This version of the model, now referred to as the operations model, was used in preparing the Truckee River Operating Agreement Draft EIS/EIR (U.S. Department of the Interior [Interior] and State of California, 1998) and the Truckee River Water Quality Settlement Agreement: Federal Water Rights Acquisition Program EIS (Interior, 2002). In addition, TMWA and consultants to the Pyramid Tribe have used, and continue to use, the operations model for water resources planning.

Sierra Hydrotech modified the operations model in 2001 to assist TROA negotiations in evaluating additional negotiations proposals. These modifications included updating the historic hydrologic database by adding water years 1998-2000, incorporating Truckee River flow regime selection criteria for cui-ui spawning, and refining Newlands Project and city of Fernley Credit Water operations. This version of the operations model was used to evaluate alternatives in the revised DEIS/EIR (Interior and State of California, 2004) and this final EIS/EIR.

B. Use of Operations Model in TROA Negotiations

As early as 1991, the parties to the TROA negotiations, and particularly the five mandatory signatories (Interior, California and Nevada, Pyramid Tribe, and Sierra Pacific (now TMWA)), discussed the need for and potential use of a model to assist in the negotiation process. The most appropriate model available to the negotiators was the model as of 1991 and its subsequent versions (as described above) that is now the operations model used in the current analysis. Because the negotiators recognized that the operations model had limitations (discussed below) and that it was a comparative, rather than a predictive, tool, they decided that it would be selectively used as the primary tool to help inform the negotiators as they considered various alternatives.

TROA has been negotiated by the representatives of the various negotiating parties. When a decision was made to use the operations model in association with the particular provision being negotiated, it was with the knowledge and recognition of the operations model's limitations. (See subsequent section, "Assumptions for Use and Limitations of Operations Model.") The technical representatives of the negotiating parties would review the data generated by the operations model, recognizing the model's limitations and using their extensive knowledge of Truckee River reservoir operations. The technical representatives were then able to provide information and make informed recommendations to their respective negotiators.

The decision-making process of the TROA negotiators has involved many professional disciplines and included use of the operations model. In coming to a decision concerning any provision of the Negotiated Agreement, the negotiators considered their respective parties' goals and objectives for TROA; professional judgment of their respective technical staffs; professional judgment of experienced Truckee River system managers; the historic hydrograph and other records for the system; and the results produced by use of the operations model with consideration of its recognized limitations.

C. Use of Operations Model in EIS/EIR

Current conditions, No Action, and the two action alternatives (1) identify water management options and (2) address water demands (i.e., M&I, agriculture, water quality, hydroelectric power generation, aquatic and riparian habitat) at various points along the Truckee River. How water resources would be managed under each alternative, and how demands would be addressed, are dependent on such variables as the amount and timing of the water supply and the demand. If these supply and demand variables are known and held constant, the capacity of each alternative to achieve its objectives can easily be calculated.

1. Input Data

The future water demand constant used in the operations model is 119,000 acre-feet per year. (Also see Section III, "Study Assumptions.") Local planning agencies and water purveyors have developed a projected growth rate to guide resource management for the next several decades, as presented in attachments C, D, and E. (Also see table 3.3 in "Surface Water" for current annual consumptive water demands in the Truckee River basin in California and Nevada.) On the basis of population projections, TMWA's M&I demand is projected to equal 119,000 acre-feet in the year 2033. Irrigation demand at that future time was then based upon the amount of agricultural water rights assumed to remain active once acquisitions and transfers to satisfy the M&I demands have been completed.

Water management criteria used in the operations model are described in "Surface Water" in Section I.C, "Current Water Management" and in Section II.C, "Reservoir Storage and Releases." These criteria identify specific thresholds for storage, release, and diversion of water that are applied each month and year on the basis of various decrees, agreements, regulations, and criteria, as well as assumed voluntary actions by owners of water rights. In real time (i.e., actual operation), special conditions or extenuating circumstances could modify application of certain operations. For current conditions and No Action, the operations model incorporates current operations. For TROA, the operations model includes most operations that are provided for in the Draft Agreement as fully implemented, required water management facilities as operational, and all water rights identified for new beneficial uses as acquired, transferred, and exercised (i.e., in the year 2033). Examples of Credit Water operations are presented in the Water Resources Appendix. For LWSA, operations different from No Action are included to meet future water demand in the absence of TROA. Proposed operations under LWSA were provided by TMWA. (See chapter 2.)

Data input to the operations model is discussed in "Surface Water," in individual sections entitled "Method of Analysis and Operations Model Input."

2. Operations Model Results

The operations model generates a 100-year data set of simulated riverflows, diversions, and return flows as well as reservoir storage, releases, and spills for current conditions and each alternative:

- End-of-month storage and average monthly releases for Truckee River reservoirs and Donner and Independence Lakes and Lahontan Reservoir
- Average monthly flows at various points in the Truckee River and tributaries

In addition to average values, these data are also expressed in terms of exceedence, which is defined as the likelihood that a value for a certain variable would be equaled or exceeded during the period of analysis. Exceedence is used to describe hydrologic conditions for reservoirs or stream locations. For example, storage associated with 90-percent exceedence would likely be relatively small because it would be equaled or exceeded 90 out of 100 times (90 percent) during the hydrologic period, and would be considered “dry” hydrologic conditions. A 50-percent exceedence would be equaled or exceeded 50 out of 100 times (50 percent) during the hydrologic period, and would be considered “median” hydrologic conditions. A 10-percent exceedence would equate to “wet” hydrologic conditions because it would be equaled or exceeded 10 out of 100 times (10 percent) during the hydrologic period.

In this study, “hydrologic condition” refers only to a specific reservoir storage or release value or amount of flow in a stream reach; it is not necessarily indicative of the magnitude of runoff or total water availability in the basin during a given water year. For most analyses, effects on resources were considered in three hydrologic conditions: wet, median, and dry. Some analyses also considered very wet (5-percent exceedence) or very dry (95-percent exceedence) hydrologic conditions, depending on the resource indicator. Exceptions to the use of these hydrologic conditions are discussed in detail in chapter 3 in “Water Quality,” “Sedimentation and Erosion,” and “Biological Resources.”

Operations model results for each alternative were compared to identify differences among parameters of interest and evaluate potential effects, as discussed previously.

D. Use and Limitations of Operations Model

The operations model was the primary tool used for analyzing and comparing alternatives for this EIS/EIR. Water managers considered the operations model to be the best model available for TROA negotiations and the best analytical tool for this document because it was specific to operations of Truckee and Carson River basin water management facilities, water demands, and schedules. Its use was accepted by all parties involved in the negotiation of TROA and preparation of the EIS/EIR. The operations model is appropriate for comparative analysis of alternatives as required by NEPA and CEQA. No other model available to the negotiators during the entire time TROA was negotiated provided comparable operational capacity or the ready review of simulated results.

Use of the operations model—both in the TROA negotiations and in the preparation of this EIS/EIR—was reasonable, in part, because it incorporates a lengthy historic data record from the Truckee River basin that reflects the variability of basin hydrology. Since the late 19th century, the climate of the study area has been characterized by relatively low average annual precipitation, with extended wet and dry periods punctuated by occasional floods and drought. Thus, precipitation and flows in the study area can vary widely—whether hourly, daily, weekly, monthly, seasonally, annually, or cyclically. This variability is often represented by using historic hydrologic data. Such hydrologic data are valuable in that they illustrate what events are possible and their frequency of occurrence. In general, the longer the hydrologic data record, the more likely it is to represent the potential range of runoff variability and their frequency of occurrence at some future time.

The use of historic hydrologic data has certain caveats. To the casual reader, the use of historic hydrologic data in the operations model could imply outcomes well into this century; however, simulated hydrologic conditions are not absolute values nor predictive of future conditions because long-term weather conditions cannot be accurately forecasted and the complete range of future operations cannot be fully anticipated. However, because the operations model incorporates a set of hydrologic data based upon historic conditions, and basin-wide water demands are based upon documented criteria, procedures, and planning material, operations model results are considered a reasonable and relevant estimate of conditions upon which to analyze and compare the alternatives.

All models have limitations, and the operations model is no exception. One limitation of the operations model is that it produces only average storage and flow results on a monthly time-step, and does not reflect shorter-term fluctuations in reservoir storage or flows. It cannot be used to analyze daily travel time between river reaches, daily or hourly release ramping rates at reservoirs, instantaneous peak flood events, or the effects of emergency operations. Thus, the operations model tends to “smooth out” normal fluctuations that occur on a real-time (e.g. daily or weekly) basis.

Second, the operations model does not account for evapotranspiration or for groundwater/surface water interactions in other than a gross statistical manner.

Third, mass-balance and accounting models, like the operations model, do not replicate historic flows throughout the basin. It was not meant to replicate such flows because the basis of the operations model is current water management and constant water demand for the entire 100-year hydrologic record. It does not lend itself to modeling historic events because demands for water have varied widely in the past, as did operations due to the construction of water management facilities. Also, various decrees and agreements have modified operations over time, particularly as reservoirs were constructed.

Fourth, as discussed previously, the operations model is not predictive as used in this study because it does not incorporate probabilistic projections of future precipitation and runoff. It uses historic runoff and does not determine the occurrence probability of certain events, such as high peak flows.

III. Study Assumptions

In addition to operations, this study is based on numerous assumptions about population level, water demands, period of analysis, and water right transfers; these are described in the following sections. (See “Surface Water” for further discussion of assumptions for water supply and demand used in the operations model.)

A.   Population Level and Water Demands

Projections of future demand (2033) on the water supply depend on several factors. The key factor is the larger future urban populations and the related transfer of water rights from irrigated agriculture to M&I use.

The entities responsible for planning for M&I water use and supply in the Lake Tahoe and Truckee River basins provided projections of future population, per capita use rate, and water demand. For Truckee Meadows, these entities are Washoe County and TMWA. For the California and other Nevada portions of the basin, these entities are California Department of Finance, California Department of Water Resources (CDWR), Tahoe Regional Planning Agency (TRPA), Nevada Division of Water Resources (NDWR), city of Fernley, and the Pyramid Tribe. (See attachments C, D, E, and G.)

Population growth in Truckee Meadows was projected to be the same under No Action, LWSA, and TROA. Water demand in Truckee Meadows also was projected to be the same under No Action, LWSA, and TROA; however, sources of water or mechanisms to provide water might differ among the alternatives. (See chapter 2.)

It was assumed that increased M&I demand on the Truckee River under the alternatives would result in additional transfer of water rights from agriculture to M&I use. TMWA’s projections of the amount of water rights to be purchased to serve growing M&I demand and the resulting reduction in agriculture also were considered.

The city of Fernley currently is supplied by groundwater sources; all new residential developments are required to provide surface water rights to serve new customers. This trend is expected to continue in the future. The water rights are being purchased from the Truckee Division of the Newlands Project. Fernley is actively pursuing transfer of ownership, purpose, and place of use of these water rights. Population growth and per capita use rates were provided by Fernley and used to establish future water demand.

Descriptions of the alternatives in chapter 2 include projections of surface and ground water usage and conservation. The Economics and Recreation Appendix contains detailed information and discussion of population projections. The Water Resources Appendix addresses future water demand and transfer of ownership, purpose, and place of use of water rights.

B. Period of Analysis

Consistent with provisions of the Negotiated Agreement, this study assumed that TROA would be fully implemented when TMWA's normal water supply for its wholesale and retail service area is equal to 119,000 acre-feet per year. Water planning documents project this condition to occur in the year 2033. If growth rates are higher or lower, TMWA will reach its full use of water earlier or later, respectively, than projected.

C. Water Right Transfers

In order to implement TROA, the following actions would require approval under applicable State law:

- Retention in storage of the consumptive use portion of all or a portion of the water that TROA signatories were entitled to divert from the Truckee River out of Floriston Rate releases, consistent with water rights and storage contracts
- Reduction in Floriston Rates releases to reflect such storage in lieu of diversions
- All water right transfers to change the place or type of use of such storage
- Pyramid Tribe obtaining the right to store Nevada unappropriated water of the Truckee River. (See Pyramid Like Appropriated Water in table 2.2.)

As of July 2007, approximately 4,736 acre-feet of water rights had been acquired to meet water quality goals in the lower Truckee River pursuant to WQSA.

SURFACE WATER

I. Affected Environment

This Affected Environment section describes current conditions for surface water supply, demand, management, and operations. Water categories used in this section and "Environmental Consequences" are defined in chapter 2, table 2.2, and the Glossary. While groundwater is mentioned because of its close relation to surface water and supply, it is described and analyzed in detail in the subsequent "Groundwater" section.

A. Supply

Surface runoff of precipitation is the primary source of water supply in the Truckee and Carson River basins, and total supply varies from year to year. Most of the available Truckee River water supply is generated upstream of the USGS stream gauge at Farad, California. For this analysis, Carson River supply is the discharge measured at the USGS stream gauge near Fort Churchill, Nevada. Most of the supply of the Truckee and Carson Rivers is produced during the spring runoff season (April to July) as the snowpack in the Sierra Nevada melts. As discussed previously, the climate of the Truckee and Carson River basins is characterized by cycles of flood and drought, and precipitation and runoff vary widely from year to year.

Historic annual discharge of the Truckee River at Farad ranges from a high of 1,768,980 acre-feet in 1983 to a low of 133,460 acre-feet in 1931. Average annual discharge at Farad is 561,800 acre-feet. Figure 3.1 shows historic annual discharge at Farad for 1900–2000.

Historic annual discharge of the Carson River near Fort Churchill ranges from a high of 804,600 acre-feet in 1983 to a low of 26,260 acre-feet in 1977. Average annual discharge at Fort Churchill is 276,000 acre-feet. Figure 3.2 shows the historic annual discharge at Fort Churchill for 1912–2000.

1. Lake Tahoe Basin

The Upper Truckee River originates in the Sierra Nevada in northeastern California and discharges to the southern end of Lake Tahoe. Numerous other creeks and streams also flow directly into Lake Tahoe. The drainage area upstream of Lake Tahoe Dam is 506 square miles, of which the lake occupies 192 square miles. Average annual net inflow to Lake Tahoe is 180,400 acre-feet.

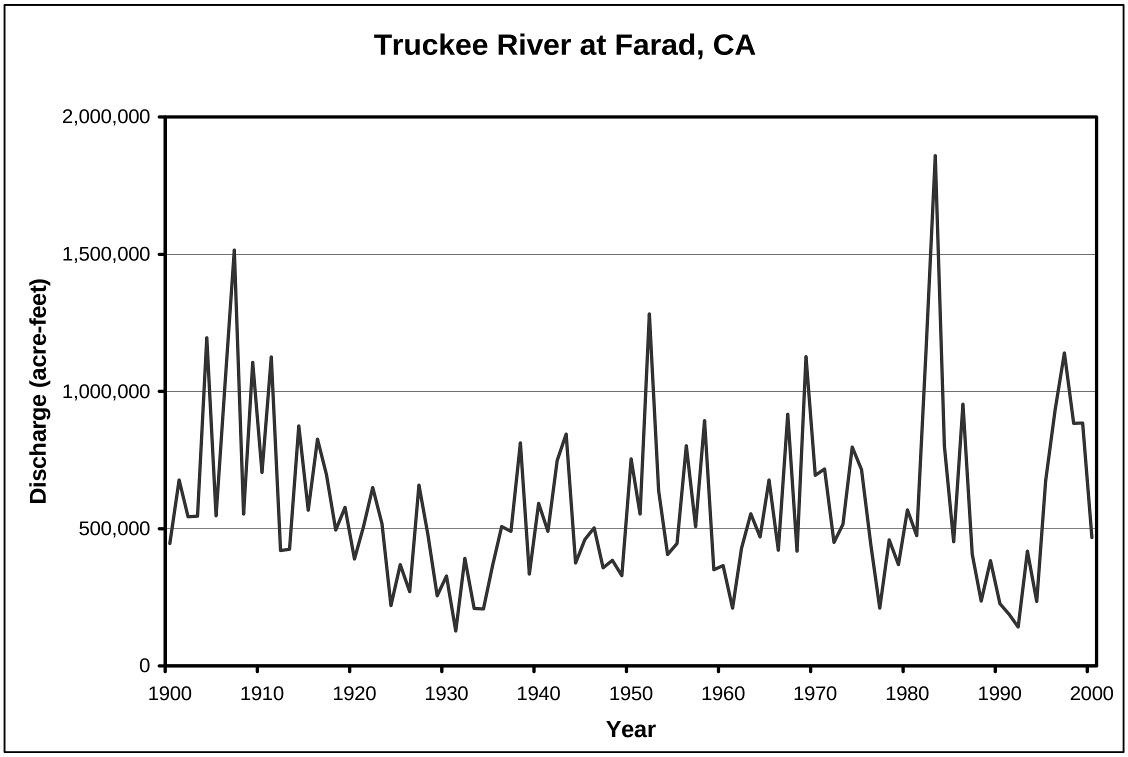


Figure 3.1—Annual discharge at Farad, California, 1900–2000.

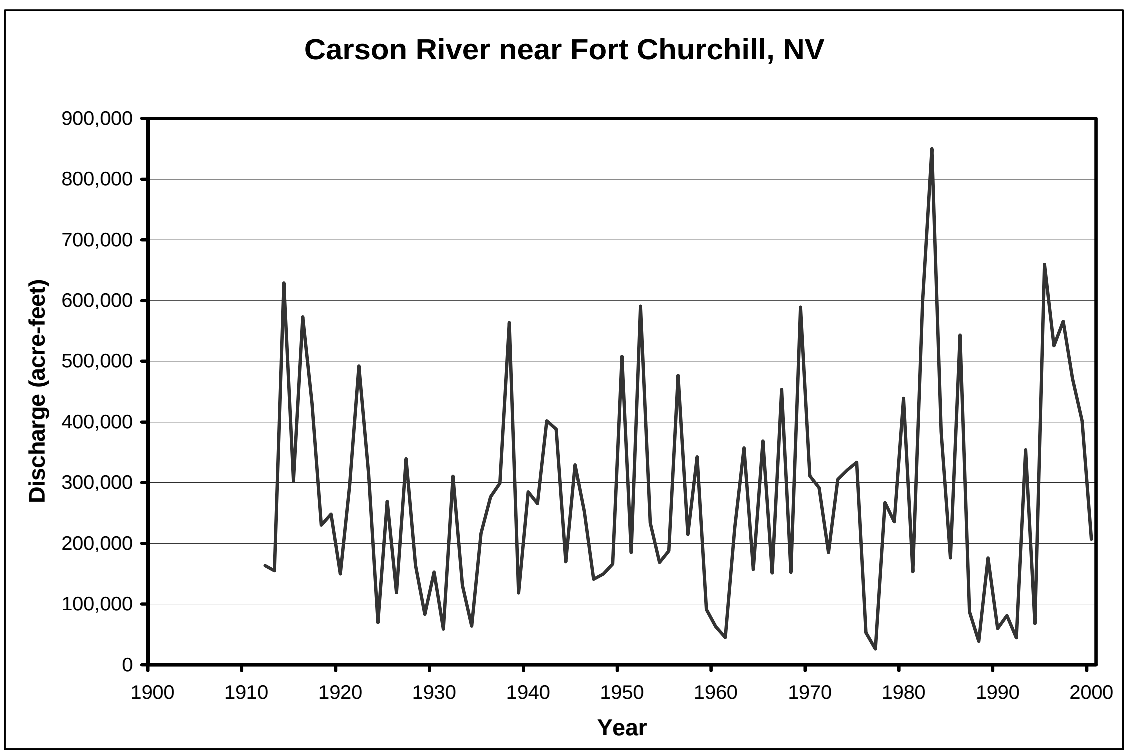


Figure 3.2—Annual discharge near Fort Churchill, Nevada, 1912–2000.

Lake Tahoe outflow is controlled by Lake Tahoe Dam, located near Tahoe City, California, at the natural outlet to the Truckee River. The natural rim of Lake Tahoe, about 400 feet upstream from the dam, is at elevation 6223.0 feet. The dam is operated, to the extent practicable, to avoid exceeding lake elevation of 6229.1 feet. The dam creates 744,600 acre-feet of useable storage between elevation 6223.0 and 6229.1 feet.

2. Truckee River and Major Tributaries

From Lake Tahoe, the Truckee River flows generally north and east through California for about 40 miles and enters Nevada near Farad. The drainage area from Lake Tahoe Dam to Farad is 426 square miles. The main tributaries are Donner, Martis, and Prosser Creeks and the Little Truckee River, all of which are regulated by dams. The unregulated drainage area covers 146 square miles and produces 30 percent of the average annual runoff at Farad.

Donner Creek drains an area of 30 square miles, enters the Truckee River about 14 miles downstream from Lake Tahoe Dam, and discharges an average of 26,300 acre-feet annually. Martis Creek and Prosser Creek join the Truckee River about 7 miles downstream from Donner Creek, with drainage areas of 20 and 50 square miles, respectively. Martis Creek annual discharge averages 19,700 acre-feet and Prosser Creek 64,000 acre-feet.

The Little Truckee River is the largest tributary to the Truckee River, with a drainage area of 173 square miles. It enters the Truckee River about 4 miles upstream of Farad. Tributaries are Independence, Sagehen, and Davies Creeks. Average annual discharge is 135,000 acre-feet.

Downstream from Farad, principal tributaries are Dog Creek and Hunter Creek, which have an average annual discharge of 4,500 and 7,000 acre-feet, respectively.

Within Truckee Meadows, Steamboat Creek drains an area of 130 square miles and contributes about 15,500 acre-feet annually to the Truckee River. Tributaries to Steamboat Creek are Galena, Evans, Thomas, and Whites Creeks. The 600-square-mile drainage area downstream from Truckee Meadows to Pyramid Lake provides only minimal contributions to the Truckee River water supply. Pyramid Lake is the terminus of the Truckee River and covers approximately 110,000 acres.

Table 3.1 presents the historic minimum, average, and maximum annual discharge at key locations in the Truckee River basin.

3. Reservoirs in the Truckee River Basin

Approximately 30 percent of the surface water supply upstream of Farad is regulated by Lake Tahoe; 40 percent is regulated by other Federal and non-Federal reservoirs located in California. The remaining 30 percent is unregulated. In general, the reservoirs store

Table 3.1—Historic Truckee River annual discharge (acre-feet per year)

Location	Period of record	Minimum	Average	Maximum
Truckee River at Tahoe City, CA	1909–2000	109	170,500	832,700
Donner Creek at Donner Lake, CA	1929–2000	5,580	26,330	60,300
Martis Creek near Truckee, CA	1959–2000	4,990	19,700	53,930
Prosser Creek downstream from Prosser Dam, CA	1943–2000	17,690	64,000	154,900
Little Truckee River downstream from Boca Dam, CA	1939–2000	40,250	135,000	340,200
Truckee River at Farad, CA	1909–2000	133,500	561,800	1,769,000
Truckee River at Reno, NV	1907–2000	76,700	509,400	1,701,000
Steamboat Creek at Steamboat, NV	1962–2000	1,390	15,550	83,000
Truckee River at Vista, NV	1900–2000	114,600	603,800	2,017,000
Truckee River downstream from Derby Diversion Dam	1918–2000	4,450	304,000	1,760,000
Truckee River near Nixon, NV	1958–2000	17,500	425,100	1,889,000

Source: USGS Water Data Report NV00-1.

Truckee River surface water in the spring and release it in the summer and early fall, primarily to meet demands in Nevada. Reservoir storage and unregulated runoff determine the water supply available to Nevada.

Donner Lake is located on Donner Creek, on the western edge of the town of Truckee, California. Donner Lake is regulated by a concrete dam constructed 1,200 feet downstream from its natural outlet. The dam is operated to avoid exceeding elevation 5935.8 feet. From November 15 through April 15, dam safety requirements specify that the discharge gates of the dam be held open; reservoir storage during this time is generally 3,000 acre-feet. During a drought condition, permission can be requested from CDWR to allow the gates to be closed in advance of April 15.

Martis Creek Reservoir is located on Martis Creek approximately 2 miles upstream of the confluence with the Truckee River. The reservoir has a capacity of 20,400 acre-feet, used for temporary storage of flood flows. Due to dam safety issues, COE's geotechnical staff monitors seepage whenever storage exceeds 6,000 acre-feet. It is quite probable that COE will not be able to utilize the full 20,400 acre-feet of available flood control storage during a flood event because of these issues.

Prosser Creek Reservoir is located on Prosser Creek about 1.5 miles upstream of the Truckee River and has a capacity of 29,800 acre-feet. Between November 1 and April 10 of the following year, reservoir storage is lowered to 9,800 acre-feet to provide 20,000 acre-feet for flood control.

Independence Lake is located on Independence Creek. An earthfill dam controls the top 28 feet of the lake above the natural outlet, providing a usable reservoir of 17,500 acre-feet. Between November 1 and April 1, dam safety requires flashboards to be removed from two bays in the spillway structure; reservoir storage during this time usually ranges from 13,000 to 15,000 acre-feet.

Stampede Reservoir is located on the Little Truckee River about 8 miles upstream of the Truckee River and 3 miles upstream of Boca Reservoir. The reservoir, which has a storage capacity of 226,500 acre-feet, reserves 22,000 acre-feet of storage between November 1 and April 10 for flood control.

Boca Reservoir, located on the Little Truckee River near its confluence with the Truckee River, has a capacity of approximately 40,900 acre-feet. Flood control storage of 8,000 acre-feet is reserved from November 1 to April 10 of the following year.

4. Truckee Canal/Lahontan Reservoir

A portion of Truckee River flow is diverted at Derby Diversion Dam through the Truckee Canal (1) directly to the Truckee Division of the Newlands Project during the irrigation season and (2) to Lahontan Reservoir to supplement the Carson River water supply to the Carson Division.

Lahontan Reservoir is located on the Carson River about 18 miles west of Fallon, Nevada, and impounds Carson River flow and, in some years, a portion of the Truckee River water diverted to the Truckee Canal. The reservoir has a storage capacity of about 313,000 acre-feet (with flashboards) and drainage area of about 1,799 square miles. Carson River discharge to Lahontan Reservoir (measured at Fort Churchill, Nevada) averaged about 276,000 acre-feet per year for the period 1911–2000. The Carson River terminates in the Carson Sink, east of Fallon, Nevada. Table 3.2 presents the historic annual minimum, average, and maximum discharge at USGS stream gauges stations on the Truckee Canal and Carson River.

Table 3.2—Historic annual Truckee Canal and Carson River annual discharge (acre-feet)

Stream gauge	Period of record	Minimum	Average	Maximum
Truckee Canal near Wadsworth, NV	1967–2000	30,985	161,500	287,500
Carson River near Fort Churchill, NV	1911–2000	26,260	276,000	804,600
Carson River downstream from Lahontan Reservoir	1967–2000	131,400	372,900	771,900

Source: USGS Water Data Report NV00-1.

5. Return Flows

Surface water return flows from irrigation and M&I uses provide water for downstream users. Irrigation return flows generally vary from 25 to 50 percent of the total water applied to the lands. TTSA-treated effluent from North Lake Tahoe, Alpine Meadows, Squaw Valley, Donner, Truckee, and the Martis Creek area percolates to the Truckee River just upstream of Martis Creek. Truckee Meadows Water Reclamation Facility (TMWRF) discharges treated effluent to Steamboat Creek, a tributary to the Truckee River. TMWRF is the largest point source of surface water returns to the river.

Groundwater also comprises a portion of the M&I water supply in the study area. See “Groundwater” for discussion.

B. Current Demands

Consumptive and nonconsumptive demands on the total water supply are described in this section. Current demands are based on documented statistics from the year 2002. These values were used in the revised DEIS/EIR and again in this final EIS/EIR for consistency between the two documents. Water categories are defined in chapter 2, table 2.2, and the Glossary.

1. Consumptive Demands

Consumptive demands are those demands for which all or a portion of the water supply is removed from the system. These demands include agricultural and M&I uses and exports from the Truckee River basin. Table 3.3 summarizes current consumptive demands for the Lake Tahoe and Truckee River basins water in California and Nevada.

Table 3.3—Current (2002) annual consumptive demands for Lake Tahoe and Truckee River basins water (acre-feet)

Agricultural demand in California	
Truckee River basin	1,800
Agricultural demands in Nevada	
Truckee Meadows	40,770
Newlands Project	
Truckee Division	18,520
Carson Division[1]	275,720
Lower Truckee River	12,040
M&I demands in California	
Lake Tahoe basin	18,700
Truckee River basin	8,570
M&I demands in Nevada	
Lake Tahoe basin	9,379
Truckee Meadows (TMWA)	83,140
Washoe County	9,900
Tracy hydroelectric powerplant	1,950
Pyramid Tribe	1,120
Fernley	3,280
Out-of-basin exports in California	
To Sierra Valley	7,000
To South Fork of American River	2,000
To Carson River[2]	4,100
Out-of-basin exports in Nevada	
To Carson River[3]	5,000
To Stead (supplied by TMWA)	1,680

[1] The Carson River supplies a majority of this demand; the Truckee River provides only a supplemental supply.
[2] Sewage effluent from South Tahoe Public Utility District.
[3] Sewage effluent from Incline Village General Improvement District, Douglas County Sewer Improvement District No. 1, and diversions from Marlette Lake.

a. Agriculture

Current average annual agricultural demand in the Truckee Meadows served from the Truckee River is 40,770 acre-feet. Major diversions from the river include Steamboat Canal and Lake, Last Chance, Orr, and Pioneer Ditches.

Downstream from Truckee Meadows are numerous other diversions from the river, including several on the Pyramid Lake Indian Reservation. The largest diversion in this portion of the river is to the Truckee Canal, primarily to support Newlands Project agriculture, to meet an annual demand of 18,520 acre-feet in the Truckee Division and to supplement Carson River flows to meet an annual demand of 275,720 acre-feet in the Carson Division.

The Pyramid Tribe holds water rights with the highest priority date (December 8, 1859), referred to as Claim Nos. 1 and 2 of the *Orr Ditch* decree. Under Claim No. 1, the Pyramid Tribe has the right to divert irrigation water in an amount not to exceed 4.71 acre-feet per acre for 3,130 acres of bottom land (14,742 acre-feet per year). Claim No. 2 gives the right to divert 5.59 acre-feet per acre for 2,745 acres of bench land (15,345 acre-feet per year).

b. M&I

Annual Truckee Meadows M&I demand is 83,140 acre-feet, of which 29,710 acre-feet return to the river. Most of this demand is met with surface water. TMWA holds a right for continuous flows of 40 cfs (28,959 acre-feet per year) for M&I use with a priority junior only to Claim Nos. 1 and 2, as defined in the Truckee River Agreement and incorporated in the *Orr Ditch* decree. In addition, TMWA holds 9,878 acre-feet of Hunter Creek rights and pumps about 14,820 acre-feet groundwater in a normal year and 22,000 acre-feet per year in a drought situation. As of 2002, TMWA held title to, or had leased, 57,170 acre-feet of agricultural water rights for M&I use.

Additional M&I demand in Nevada includes 9,379 acre-feet in the Lake Tahoe basin, which is met by surface water. M&I demands of 1,120 acre-feet on the Pyramid Lake Indian Reservation and 3,280 acre-feet in Fernley currently are met by groundwater.

State of Nevada Permit Nos. 48061 and 48494 allocate the remaining waters of the Nevada portion of the Truckee River to the Pyramid Tribe. Currently this is under appeal. If the Nevada State Engineer’s ruling is upheld, the Nevada portion of the Truckee River and its tributaries would be fully appropriated.

In California, total M&I demand is approximately 27,300 acre-feet per year, with about 18,700 acre-feet in the Lake Tahoe basin and 8,600 acre-feet in the Truckee River basin. In the Truckee River basin, surface water meets about 1,000 acre-feet of the demand and groundwater meets about 7,600 acre-feet. Some of the water is exported out of the Truckee River basin, as shown in table 3.3.

2. Nonconsumptive Demands

Nonconsumptive demands are those in which the water supply provides beneficial uses but is not diminished in quantity for downstream users (table 3.4). In the Truckee River basin, these demands include hydroelectric power generation, flows to provide and maintain fish habitat, and reservoir storage for recreation.

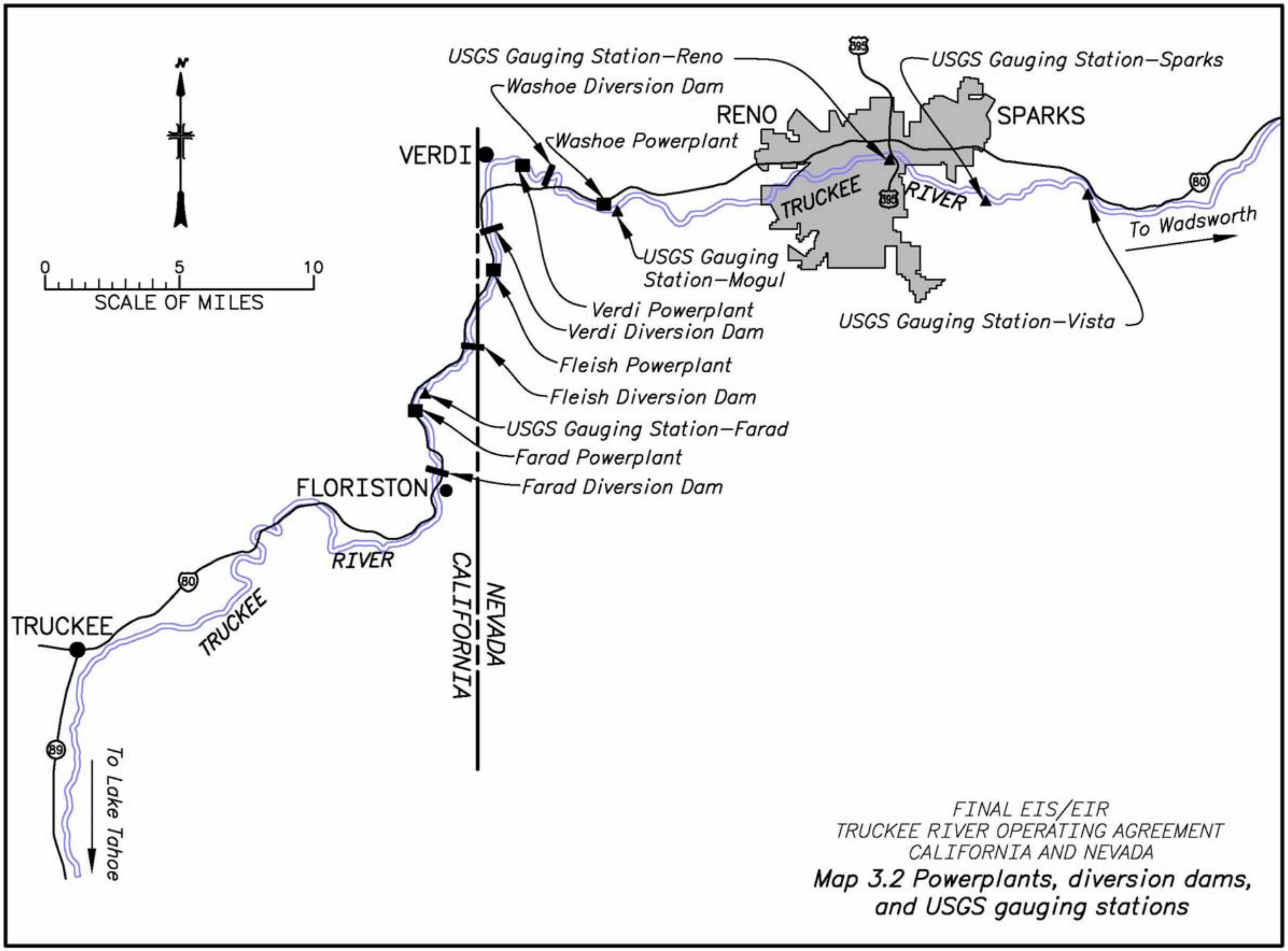
Table 3.4—Current (2002) nonconsumptive water demands (cfs) in the Lake Tahoe and Truckee River basins

Hydroelectric power generation (maximum diversion right) in California	
Farad	400
Hydroelectric power generation (maximum diversion right) in Nevada	
Fleish	327
Verdi	399
Washoe	396
Minimum releases in California	
Lake Tahoe	
October-March	50
April-September	70
Donner Lake	2-3
Prosser Creek Reservoir	5 (or inflow to reservoir if less than 5 cfs)
Independence Lake	2
Stampede Reservoir[1]	30
Boca Reservoir	0
Farad hydroelectric powerplant bypass	150
Minimum flows in Nevada	
Fleish hydroelectric powerplant bypass	50
Verdi hydroelectric powerplant bypass	50
Washoe hydroelectric powerplant bypass	50

[1]The minimum release of 30 cfs from Stampede Reservoir is maintained under an informal agreement between Reclamation and the California Department of Fish and Game.

a. Hydroelectric Power Generation

Four run-of-the-river hydroelectric powerplants are located along the Truckee River between the Little Truckee River and Reno: Farad, Fleish, Verdi, and Washoe (map 3.2). To generate power, water is diverted to flumes (i.e., wooden or earthen canals) that convey the water to the riverside plants, where the water is passed through penstocks and rotating turbines or through bypass spillways; the water is then returned to the river. Historically, stretches of the river between the diversion structure and the point of return frequently were dry during portions of the year. TMWA has agreed to maintain minimum bypass flows of 50 cfs at each of the four hydroelectric powerplant diversion dams; in addition, as a condition of rebuilding the Farad Diversion Dam, SWRCB will



FINAL EIS/EIR
TRUCKEE RIVER OPERATING AGREEMENT
CALIFORNIA AND NEVADA

Map 3.2 Powerplants, diversion dams, and USGS gauging stations

require TMWA to maintain at the Farad Diversion Dam a minimum bypass flow of 150 cfs or the Truckee River flow immediately upstream of the diversion dam, whichever is less.[2]

Two hydroelectric powerplants at Stampede Dam have a combined capacity of 3.65 megawatts and a combined delivery rate of 300 cfs. Two hydroelectric powerplants at Lahontan Dam, with a capacity of 6.3 megawatts and delivery rate of 710 cfs, can receive water from the Truckee Canal or Lahontan Reservoir. Another hydroelectric powerplant is located on the V-Line Canal of the Newlands Project. The non-consumptive demands presented in table 3.4 have water rights for diversions. While the United States has an *Alpine* decree right for generating hydroelectric power at Lahontan Reservoir, there is no required diversion to meet hydroelectric power demands and hydroelectric power is to be generated incidental to reservoir releases.

b. Minimum Reservoir Releases

Table 3.4 lists current minimum releases by location. The minimum release of 30 cfs from Stampede Reservoir is maintained under an informal agreement between Reclamation and the California Department of Fish and Game (CDFG).

c. Recreation Storage

In the Truckee River basin, recreational interests are generally served incidental to water rights.

C. Current Water Management

Numerous laws, court decrees, and agreements govern the current operation of reservoirs in the Truckee and Carson River basins. Some of the key operating constraints on the Truckee River are the *Truckee River General Electric* decree; *Orr Ditch* decree which incorporated the TRA; and TPEA. The *Alpine* decree governs the exercise of Carson River basin water rights, and OCAP regulates operations on the Newlands Project.

1. *Truckee River General Electric* Decree

The *Truckee River General Electric* decree set forth the operating constraints for Lake Tahoe, granted Reclamation the right to use Lake Tahoe dam to regulate streamflows and incorporated the original Floriston Rates (later modified by TRA). Floriston Rates provided minimum flows of 500 cfs from March through September and 400 cfs the remainder of the year, as long as water was available in Lake Tahoe. Floriston Rates were intended to provide sufficient streamflow for a pulp and paper mill near Floriston, California, and the four run-of-the-river hydroelectric powerplants. (Initially, Floriston Rates were measured at the Iceland, California, stream gauge.)

[2] It was assumed for this final EIS/EIR that the Farad Diversion Dam has been rebuilt.

2. *Orr Ditch* Decree

The *Orr Ditch* decree was entered by the U.S. District Court for the District of Nevada in 1944 in *United States* v. *Orr Water Ditch Co.*, *et al*., No. A-3 in Equity, an action brought by the United States in 1913 to quiet title to water rights on the Truckee River and storage in Lake Tahoe. The *Orr Ditch* decree adjudicated water rights of the Truckee River in Nevada and established amounts, places and types of use, and priorities of the various rights, including the United States' right to store water in Lake Tahoe. The decree also incorporated the 1935 TRA as binding among Sierra Pacific Power Company (Sierra Pacific), TCID, WCWCD, Interior, and certain other Truckee River water users ("parties of the fifth part"). TRA is an operating agreement that, among other things, provided for reduced Floriston Rates, and for the construction of what is now Boca Reservoir. The *Orr Ditch* decree, 1915 *Truckee River General Electric* decree, and Tahoe-Prosser Exchange Agreement (discussed in the following paragraph) provide the current operational framework and rules for Truckee River reservoirs. The provisions of the *Orr Ditch* decree are administered by the Federal Water Master appointed by the *Orr Ditch* court.

3. Tahoe-Prosser Exchange Agreement

The Tahoe-Prosser Exchange Agreement supplements TRA with additional criteria for operations of Lake Tahoe and Prosser Creek Reservoir. TPEA allows specific streamflow releases to be made from Lake Tahoe when releases are not required to meet Floriston Rates. Minimum releases of 70 cfs from April through September and 50 cfs the remainder of the year are made from Lake Tahoe when storage in Prosser Creek Reservoir is available for an exchange or when an equivalent amount of water in excess of Prosser Creek minimum releases of 5 cfs is available for storage. If inflow to Prosser Creek is less than these releases and no storage is available for exchange, releases from Lake Tahoe are reduced to the amount of inflow stored in Prosser Creek Reservoir.

4. *Alpine* Decree

The *Alpine* decree is the 1980 adjudication of the Carson River water rights and priorities in California and Nevada. Under the decree, waters of the Carson River are fully appropriated.

5. OCAP

OCAP (referred to in TROA as Truckee Canal Diversion Criteria) is a Federal regulation promulgated by the Secretary of the Interior that establishes procedures to define the annual water demand of the Newlands Project and regulates the diversion of water from the Truckee River to meet that demand consistent with the *Alpine* and *Orr Ditch* decrees and the Secretary's trust responsibilities to the Pyramid Tribe. OCAP includes provisions for a maximum annual diversion, implementation of conservation measures to improve project efficiency, and criteria for diverting Truckee River water to the Newlands Project for agricultural use and storage in Lahontan Reservoir.

6. *Carson-Truckee Water Conservancy District* v. *Watt,* 1982

The Federal court ruled that the Secretary must use storage in Stampede Reservoir for the conservation of Pyramid Lake fishes because the Endangered Species Act of 1973, as amended (ESA) took precedence over any obligation to contract for delivery of water for irrigation and M&I uses. This ruling guides current operations of Stampede Reservoir.

7. Interim Storage Agreement

This 1994 agreement among Interior, Sierra Pacific, WCWCD, and the Pyramid Tribe allows Sierra Pacific (now TMWA) to store privately owned water from Independence Lake and Donner Lake in Stampede and Boca Reservoirs; this water would be used to meet domestic and M&I needs in Truckee Meadows during a drought situation. Up to 14,000 acre-feet of privately owned water can be stored; however, any privately owned water in excess of 5,000 acre-feet is converted to Fish Water on September 1 of each year.

8. Truckee River Water Quality Settlement Agreement

The 1996 Truckee River Water Quality Settlement Agreement established a program to improve Truckee River water quality through the purchase and transfer of Truckee River water rights for the purpose of maintaining streamflows. Water associated with WQSA water rights could be stored in Stampede and Prosser Creek Reservoirs and managed by the WQSA parties for water quality and aesthetic purposes.

D. Current Operations

This section describes current operations of reservoirs for flood control, dam safety, minimum releases, storage, and streamflows. These operations were modeled for this study.

1. Flood Control

Martis Creek Reservoir is operated only for flood control purposes. Temporary storage space is required by COE in several of the reservoirs as follows:

- Prosser Creek Reservoir - 20,000 acre-feet by November 1
- Stampede Reservoir - 22,000 acre-feet by November 1
- Boca Reservoir - 8,000 acre-feet by November 1

Stored water may be required to be released to meet these requirements.

Lake Tahoe is operated to limit high-water damage to lakeshore property, and releases to the Truckee River are made to avoid exceeding elevation 6229.1 feet.

Flood waters are stored temporarily in Prosser Creek, Stampede, Boca, and Martis Creek Reservoirs when Truckee River flows at Reno are 6,000 cfs or greater. Even with no releases being made from reservoirs during a flood event, unregulated runoff can exceed that amount.

2. Dam Safety Requirements

To meet dam safety requirements, Donner Lake's two upper gates must remain open from November 15 to April 15 in the following year. Dam safety requirements for Independence Lake require clearing of the spillway prior to the rainy season. In general, storage in Independence Lake is maintained at 14,500 acre-feet during the winter.

3. Minimum and Bypass Flow Requirements

Minimum reservoir releases and hydroelectric powerplant bypass flows are shown in table 3.4. Lake Tahoe minimum releases of 50 cfs October–March and 70 cfs April-September, when release is not required for Floriston Rates, are subject to the availability of water in Prosser Creek Reservoir to exchange.

4. Floriston Rates

Floriston Rates are met by unregulated flows and releases of Project Water. Releases of Tahoe-Prosser Exchange Water stored in Prosser Creek, primarily late in the irrigation season, and Project Water stored in Lake Tahoe and Boca Reservoir are made to meet all or a portion of Floriston Rates when unregulated flows are insufficient to meet Floriston Rates, generally in the following order:

April through October:

When Lake Tahoe elevation is at or below 6225.5 feet, Project Water stored in Lake Tahoe is released first (in anticipation of the reservoir falling below the natural outlet) and then Project Water stored in Boca Reservoir.

When Lake Tahoe elevation is above 6225.5 feet, Project Water stored in Boca Reservoir is released first and then Project Water stored in Lake Tahoe. (The Federal Water Master may vary this to maintain relatively constant flow in the river downstream from Lake Tahoe.)

Tahoe-Prosser Exchange Water stored in Prosser Creek Reservoir is also released in combination with releases from Lake Tahoe and Boca Reservoir for Floriston Rates. Tahoe-Prosser Exchange Water tends to be released later in the season (June through October) and, because its storage may not interfere with flood control requirements, the Federal Water Master strives to release all Tahoe-Prosser Exchange Water before November 1.

November through March:

Boca Reservoir is the main source of water for Floriston Rates, with contributions from Lake Tahoe.

When Floriston Rates cannot be met by unregulated flows and Project Water releases from Lake Tahoe and Prosser Creek and Boca Reservoirs, priority for use of the available water is subject to the *Orr Ditch* decree.

5. Storing Water in Reservoirs

Water may be stored in Donner and Independence Lakes adverse to Floriston Rates. Donner Creek inflow may be stored in Donner Lake after April 15 of each year. Independence Lake has a right to store the first 3,000 acre-feet of Independence Creek inflow each year.

Water cannot be stored in Lake Tahoe or in Prosser Creek, Stampede, or Boca Reservoirs until Floriston Rates are met. When unregulated flows meet or exceed Floriston Rates, Lake Tahoe has the first right to store Project Water. If Floriston Rates are still exceeded, up to 25,000 acre-feet of Project Water may be stored in Boca Reservoir.

After the 25,000 acre-feet of water is stored in Boca Reservoir, another condition must be met before additional Truckee River water may be stored: sufficient water must be available to meet Truckee Canal diversion requirements for the Newlands Project pursuant to OCAP.

An additional 15,850 acre-feet may now be stored to fill Boca Reservoir. After Boca Reservoir fills, Independence Lake has the right to store an additional 14,500 acre-feet of Independence Creek inflow, if available.

Stampede Reservoir has the next right to store up to 126,000 acre-feet, followed by Prosser Creek Reservoir, with a right to store up to 30,000 acre-feet of Project Water. Project Water stored in Prosser Creek Reservoir not needed for the Tahoe-Prosser Exchange and Project Water stored in Stampede Reservoir are used to meet the flow requirements of Pyramid Lake fishes. Prosser Creek Reservoir may store Tahoe-Prosser Exchange Water when appropriate conditions exist.

6. Truckee River Operations for Pyramid Lake Fishes

Project Water stored in Stampede and Prosser Creek Reservoirs for the benefit of Pyramid Lake fishes is currently managed using flow regime criteria developed by FWS based on six hydrologic year types and the amount of Stampede Project Water (and Fish Credit Water under TROA) in storage on March 1 (referred to as the six-flow regime in “Fish in Truckee River and Affected Tributaries”). In addition to biological requirements of fish, flow criteria also incorporate ecosystem considerations, such as establishment and maintenance of willow and cottonwoods. (See "Fish in Truckee River and Affected Tributaries" for a detailed discussion and analysis.) Table 3.5 presents hydrologic year types; table 3.6 presents Stampede Reservoir storage designations.

Table 3.5—Hydrologic year types (based on Stampede Reservoir March through July inflow [acre-feet])

March through July inflow	Hydrologic year type
Greater than 150,000	Wet
Greater than 107,000 and less than or equal to 150,000	Above average
Greater than 76,000 and less than or equal to 107,000	Average
Greater than 52,000 and less than or equal to 76,000	Below average
Greater than 30,000 and less than or equal to 52,000	Dry
Less than 30,000	Critical

Table 3.6—Stampede Reservoir storage designation (based on Fish Water in storage on March 1 [acre-feet])

Fish Water in storage	Storage designation
Greater than 200,000	Full
Greater than 150,000 and less than or equal to 200,000	High
Greater than 100,000 and less than or equal to 150,000	Low
Less than or equal to 100,000	Critical

Using the hydrologic year type and a Stampede Reservoir storage designation, a flow regime is selected, as shown in table 3.7.

Table 3.7—Flow regime selection

Storage designation	Hydrologic year type					
	Wet	Above average	Average	Below average	Dry	Critical
Full	1	1	1	1	3	4
High	1	1	2	2	4	5
Low	1	2	3	4	6	6
Critical	2	3	5	6	6	6

Each flow regime has a set of monthly inflow targets to Pyramid Lake. An appropriate regime is selected each month, from March through July, as the forecast is updated. A single flow regime is selected for operations from August through the following February. Table 3.8 presents the monthly inflow targets for each flow regime.

Table 3.8—Pyramid Lake monthly inflow targets (cfs) for flow regime Nos. 1-6

	1	2	3	4	5	6
January	160	150	120	110	100	90
February	160	150	120	110	100	90
March	290	220	200	160	160	140
April	590	490	420	350	300	200
May	1,000	800	600	530	400	300
June	800	600	500	400	270	170
July	300	300	300	200	150	120
August	200	200	200	200	150	110
September	170	170	120	110	100	100
October	160	150	120	110	100	100
November	160	150	120	110	100	90
December	160	150	120	110	100	90

These inflow targets are modified in years with substantial spring runoff. When both May and June inflow to Pyramid Lake exceeds 1,000 cfs, the August and September inflow targets are set to 300 cfs.

When lower Truckee River flow is below the inflow target, Fish Water is released from Prosser Creek and/or Stampede Reservoirs to supplement the flow.

See chapter 2 for discussions of operations under No Action, LWSA, and TROA.

II. Environmental Consequences

A. Introduction

Modifying operations of Truckee River reservoirs could affect reservoir storage and releases and the quality, quantity, timing, and duration of flows. For this analysis, the effects of changes in storage and flows were evaluated using the following parameters:

- Total end-of-month storage for the following reservoirs in wet, median, and dry hydrologic conditions (i.e., 10-, 50-, and 90-percent probabilities of exceedence, respectively)
    - Lake Tahoe
    - Donner Lake
    - Prosser Creek Reservoir
    - Independence Lake
    - Stampede Reservoir
    - Boca Reservoir
- Individual end-of-month storage and average monthly releases in wet, median, and dry hydrologic conditions for all of the above reservoirs, as well as for Lahontan Reservoir
- Average monthly Truckee River flows in wet, median, and dry hydrologic conditions for the following locations:
    - Farad, California
    - Vista, Nevada
- Pyramid Lake inflow (average monthly Truckee River flows at Nixon, Nevada) in wet, median, and dry hydrologic conditions and comparison of simulated lake elevations
- Exercise of water rights to meet the following demands in the minimum supply year:
    - Agriculture
        - Truckee Meadows
        - Newlands Project
            - Truckee Division
            - Carson Division
        - Lower Truckee River

The minimum supply year (or minimum annual water supply) is defined as the calendar year with the least supply to serve water rights over the 100-year period of analysis.

- M&I
    - Lake Tahoe
    - Truckee River in California
    - Truckee Meadows
    - Fernley
    - Lower Truckee River

Operations model results are presented for 10-, 50-, and 90-percent probabilities of exceedence, and these monthly results are summarized and analyzed in this section. Complete operations model output is contained in the Water Resources Appendix.

B. Summary of Effects

The effects on surface water are summarized in tables 3.9 (reservoir storage and releases), 3.10 (Truckee River flows), 3.11 (Pyramid Lake), and 3.12 (exercise of water rights).

The total amount of water stored in Truckee River reservoirs and Donner and Independence Lakes—and that is available for release—is an indicator of the water supply that can meet consumptive and nonconsumptive demands. Operations model results show that, under TROA, the total amount of water stored is greater than under No Action, LWSA, or current conditions, primarily in Stampede, Boca, and Prosser Creek Reservoirs.

Each alternative includes target releases for environmental and recreational benefits. In dry hydrologic conditions, operations model results show that flows in Independence Creek, Little Truckee River, and Prosser Creek are appreciably greater under TROA than under the other alternatives because of greater minimum flow releases and the ability to exchange Credit Water among the reservoirs. In addition, in dry hydrologic conditions, Truckee River flow through and downstream from Truckee Meadows is greater under all alternatives than under current conditions because of the greater amount of storage from Credit Waters available for release.

In Truckee Meadows, agricultural demand is not met in all years under current conditions and the alternatives.

For the Newlands Project, it is assumed that, in the future, all Truckee Division water rights would be acquired for Fernley M&I and water quality improvement purposes. Under current conditions and the three alternatives, Carson Division demands are met in wet, median, and dry hydrologic conditions; they are not met in hydrologic conditions with less than a 10 percent probability of exceedence (i.e., in drier than dry hydrologic conditions) under any of the alternatives.

Table 3.9—Summary of effects on end-of-month reservoir storage (acre-feet) and average monthly releases

Location	Current conditions	No Action	LWSA	TROA
Total	Wet: 946,300 Median: 790,000 Dry: 64,000	Slightly less than under current conditions	Similar to No Action	Much greater than under No Action or current conditions
Lake Tahoe	Wet: 672,900 Median: 557,100 Dry: 52,600	Slightly less storage and similar releases as under current conditions	Similar storage and releases as under No Action	Similar storage and much greater May-June releases and less August-January releases than under No Action or current conditions
Donner Lake	Wet: 6,500 Median: 5,800 Dry: 5,100	Similar storage and releases as under current conditions	Similar storage and releases as under No Action	Similar storage, except slightly less storage in July and August than under No Action or current conditions; slightly greater June-August releases, less September releases, and greater October releases than under No Action or current conditions
Prosser Creek Reservoir	Wet: 18,800	Wet: similar storage and releases as under current conditions	Similar to No Action in all three hydrologic conditions	Wet: similar storage and releases as under No Action or current conditions
	Median: 14,400	Median: greater August-September storage; less May-July releases; much greater October releases than under current conditions		Median: greater May-September storage; less May-July releases and much greater September-October releases than under than under No Action or current conditions
	Dry: 3,100	Dry: much greater January-December storage; less May-July releases; greater October releases than under current conditions		Dry: much greater January-December storage; less May releases; greater August-October releases than under No Action or current conditions

Table 3.9—Summary of effects on end-of-month reservoir storage and average monthly releases (acre-feet, unless noted) – continued

Location	Current conditions	No Action	LWSA	TROA
Independence Lake	Wet: 15,700	Similar storage and releases as under current conditions	Similar storage and releases as under No Action	Wet: similar storage and releases as under No Action or current conditions, except less releases in September
	Median: 15,600			Median: similar storage and releases as under No Action or current conditions, except greater February and August releases and less March and September releases
	Dry: 15,000			Dry: in general, slightly less January-December storage; slightly greater June-September releases; similar October-May releases as under No Action or current conditions
Stampede Reservoir	Wet: 212,900	Wet: slightly greater August-September storage and similar releases as under current conditions	Similar storage and releases as under No Action	Wet: greater May-September storage and greater September-November releases than under No Action or current conditions
	Median: 181,200	Median: similar January-December storage and lower August-September releases than under current conditions		Median: much greater January-December storage; less November-July releases and much greater September-October releases than under No Action or current conditions
	Dry: 22,000	Dry: similar January-December storage and greater March and July releases than under current conditions		Dry: much greater January-December storage and releases than under No Action or current conditions

Table 3.9—Summary of effects on end-of-month reservoir storage and average monthly releases (acre-feet, unless noted) – continued

Location	Current conditions	No Action	LWSA	TROA
Boca Reservoir	Wet: 34,500	Similar storage and releases as under current conditions	Similar storage and releases as under No Action	Wet: less August and greater October-December storage than under No Action or current conditions
	Median: 20,300			Median: greater August-March storage than under No Action or current conditions
	Dry: 3,400			Dry: greater January-December storage than under No Action or current conditions
Lahontan Reservoir	Wet: 277,300	Wet: slightly greater September-February storage; similar releases as under current conditions	Similar to No Action	Similar to No Action
	Median: 160,500	Median and dry: less January-December storage; less April-September releases than under current conditions		
	Dry: 99,100			

Table 3.10—Summary of effects on average monthly Truckee River flows (cfs)

Location	Current conditions	No Action	LWSA	TROA
Farad	Wet: 1,420	Slightly less than under current conditions	Similar to No Action	Wet: greater December-June flows than under No Action or current conditions and less August-September flows than under No Action or current conditions
	Median: 650			Median: less November-February flows than under No Action or current conditions and less July-September flows than under No Action or current conditions
	Dry: 430			In general, in dry to very dry hydrologic conditions: greater July-September flows than under No Action or current conditions and less November-June flows than under No Action or current conditions
Vista	Wet: 1,460	Generally slightly less than under current conditions	Similar to No Action	Wet: slightly greater December-June flows than under No Action or current conditions
	Median: 640			Median: less November-February flows than under No Action or current conditions
	Dry: 400			Dry: greater July-October flows than under No Action or current conditions

Table 3.11—Summary of effects on Pyramid Lake

Location	Current conditions	No Action	LWSA	TROA
Pyramid Lake	Ending elevation: 49 feet higher by the end of 100-year period of analysis Ending storage: 28,430,000 acre-feet Average inflow: 496,720 acre-feet per year	Ending elevation, storage, and inflow less than under current conditions	Ending elevation, storage, and inflow less than under No Action or current conditions	Ending elevation, storage, and inflow greater than under No Action or current conditions
Nixon (Pyramid Lake inflow)	Wet: 1,410 cfs	Wet: Generally slightly less flows than under current conditions	Similar to No Action	Wet: slightly greater December-June flows than under No Action or current conditions
	Median: 600 cfs	Median to dry: greater August-September flows than under current conditions		Median: less November-February flows than under No Action or current conditions and similar to slightly greater July-October flows than under No Action or current conditions
	Dry: 150 cfs			Dry: slightly greater August-October flows than under No Action or current conditions

Table 3.12—Summary of effects on exercise of water rights to meet demands

Location	Current Conditions	No Action	LWSA	TROA
Agricultural				
Truckee Meadows	Demand of 40,770 acre-feet per year and 21.3 percent of demand met in minimum supply year	Much less demand and a greater percent of demand met in minimum supply year than under current conditions	Same demand as under No Action and a greater percent of demand met in minimum supply year than under current conditions	Much less demand than under No Action or current conditions and greater percent of demand met in minimum supply year than under No Action or current conditions
Newlands Project Truckee Division	Demand of 18,520 acre-feet per year and 51.5 percent of demand met in minimum supply year	No demand; water rights acquired by TMWA and Fernley	Same as under No Action	Same as under No Action, i.e., no demand; water rights acquired by TMWA and Fernley
Newlands Project Carson Division	Demand of 275,720 acre-feet per year and 47.2 percent of demand met in minimum supply year	Slightly less demand and less percent of demand met in minimum supply year than under current conditions	Same demand and slightly less percent of demand met in minimum supply year than under No Action; slightly less demand and less percent of demand met in minimum supply year than under current conditions	Same demand and similar percent of demand met in the minimum supply year as under No Action; slightly less demand and less percent of demand met in minimum supply year than under current conditions
Lower Truckee River	Demand of 12,040 acre-feet per year and 100 percent of demand met in minimum supply year	Much greater demand and same percent of demand met in minimum supply year as under current conditions	Same as under No Action	Same as under No Action, i.e., much greater demand and same percent of demand met in minimum supply year as under current conditions
M&I				
Lake Tahoe California	Demand of 18,700 acre-feet per year and 100 percent of demand met in minimum supply year	Much greater demand and same percent of demand met in minimum supply year as under current conditions	Same as under No Action	Same as under No Action, i.e., much greater demand and same percent of demand met in minimum supply year as under current conditions

Table 3.12—Summary of effects on exercise of water rights to meet demands – continued

Demand	Current Conditions	No Action	LWSA	TROA
Lake Tahoe Nevada	Demand of 11,000 acre-feet year and 100 percent of demand met in minimum supply year	Same demand and same percent of demand met in minimum supply year as under current conditions	Same as under No Action	Same as under No Action, i.e., same demand and same percent of demand met in minimum supply year as under current conditions
Truckee River California	Demand of 8,570 acre-feet per year and 100 percent of demand met in minimum supply year	Much greater demand and same percent of demand met in minimum supply year as under current conditions	Same as under No Action	Same as under No Action, i.e., much greater demand and same percent of demand met in minimum supply year as under current conditions
Truckee Meadows	Demand of 83,140 acre-feet per year and 100 percent of demand met in minimum supply year	Supply insufficient to meet demand of 119,000 acre-feet in all drought years	Supply insufficient to meet demand of 119,000 acre-feet in all drought years	Supply sufficient to meet demand of 119,000 acre-feet in all drought years
Fernley	Demand of 3,280 acre-feet per year and 100 percent of demand met in minimum supply year by groundwater	Much greater demand and less percent of demand met in minimum supply year as under current conditions	Same as under No Action	Same as under No Action, i.e., much greater demand and less percent of demand met in minimum supply year as under current conditions
Lower Truckee River	Demand of 1,120 acre-feet per year and 100 percent of demand met in minimum supply year	Much greater demand and same percent of demand met in minimum supply year as under current conditions	Same as under No Action	Same as under No Action, i.e., much greater demand and same percent of demand met in minimum supply year as under current conditions

In California, M&I demands in the Lake Tahoe and Truckee River basins are met under current conditions and the alternatives. In Nevada, M&I demand in the Lake Tahoe basin is met under current conditions and the alternatives. Truckee Meadows M&I demand is met under current conditions. In the minimum supply year, Truckee Meadows M&I supply under TROA is greater than under No Action or LWSA; M&I water supply during the drought periods is greater under TROA than under No Action and LWSA in all years. Fernley M&I demand is met by groundwater under current conditions. A portion of Fernley future M&I demand is met by transfer of Truckee Division agricultural water rights. In the minimum supply year, M&I supply is the same under all alternatives. Lower Truckee River agricultural and M&I demands are met under all alternatives.

C. Reservoir Storage and Releases

1. Method of Analysis and Operations Model Input

This section describes the method used to calculate reservoir storage and releases and the supply and demand assumptions used in the operations model. Subsequent sections provide information on the effects of the various alternatives on reservoir operations and resulting streamflows. For a description of the operations model, see Section II, “Truckee River Operations Model,” in “General Methods and Assumptions.”

a. Method

Parameters identified in the Surface Water section were used to identify indicators analyzed in the subsequent resource sections. Parameters related to beneficial uses (e.g., exercise of water rights, minimum flows, recreation storage thresholds) and unique resources (e.g., special status species, fish, and riparian habitat) provide an analytical basis for this document.

Operations model results for reservoir storage and releases and flows in wet, median, and dry hydrologic conditions under No Action, LWSA, and TROA were compared to the results for modeled current conditions. Operations model results under LWSA and TROA also were compared to results under No Action. In addition, operations model results were analyzed to identify the causes of any differences between the alternatives and current conditions. See Section I, “Comparative Evaluation of Alternatives” in “General Methods and Assumptions” for further explanation.

Tables in the Water Resources Appendix (Exhibits 6-11) present reservoir storage and elevation and average monthly releases for each reservoir under current conditions, No Action, LWSA, and TROA, as generated by the operations model. The operations model input files, a description of what they represent, and output summary files are contained in the Water Resources Appendix, Exhibits 4 and 5. The output files also are included in the Water Resources Appendix.

b. Input Assumptions

See Section II, “Truckee River Operations Model,” and Section III, “Study Assumptions,” in “General Methods and Assumptions” for a description of model input assumptions.

(1) Water Supply

For current conditions, No Action, LWSA, and TROA, the operations model uses 100 years of historic hydrologic data for the period October 1900 to September 2000 to calculate the availability of water supply to meet demands. Historic flows (from gauging station records), historic reservoir elevations, local area evaporation and precipitation records, and estimated flows (when gauging station records were not available) were used to generate basic water supply data. Input values for initial reservoir storage were calculated by averaging the historic end-of-September storage for the period 1993–2002. This period is recent and represents a wide range of hydrologic conditions.

The operations model does not perform any operations calculations for demands in the Lake Tahoe basin. The effects of water demands were incorporated into the monthly net inflow data for Lake Tahoe and were assumed to be met with no shortages. Lake Tahoe inflow was developed assuming California demands of 23,000 acre-feet and Nevada demands of 11,000 acre-feet annually in the Lake Tahoe basin. (The current estimate of annual use is 18,700 acre-feet in California and 11,000 acre-feet in Nevada.) Because current demands are less than future demands, Lake Tahoe inflow was increased by 1,400 acre-feet per year in the current conditions simulation to account for less consumptive use in the Lake Tahoe basin.

(2) Water Demand

Table 3.13 presents annual consumptive demands in the study area that were included as input to the operations model.

(a) Current Conditions Modeled Demands

Current conditions modeled demands were based on 2002 data. Currently, M&I demands for the Pyramid Tribe and Fernley are met by groundwater and are not modeled. Return flows from irrigation, river losses, and local inflow in Truckee Meadows were based on another computer model, the Truckee Meadows model, which estimates the net effects of urbanization on these parameters. Estimated average annual return flows from TMWRF are 29,710 acre-feet per year. Minimum reservoir releases, hydroelectric powerplant bypass flows, and hydroelectric powerplant demands are shown in table 3.4. No recreational pool or water quality targets are modeled for current conditions. All operations discussed previously in “Current Operations” are modeled.

(b) No Action Modeled Demands

The operations model uses estimates of future demands for water based on population and water use projections made by water resource planning entities in California and Nevada: Washoe County, TMWA, TRPA, California Department of Finance, CDWR, NDWR, Fernley, and the Pyramid Tribe.

Under No Action, no additional storage facilities would be constructed to provide a drought supply for Truckee Meadows M&I demand. In drought years under No Action, the groundwater would be operated conjunctively to supplement available surface water.

In its 1995–2015 Water Resources Plan, Sierra Pacific (1994) evaluated a number of options to provide a reliable water supply for Truckee Meadows, including 18 alternative local reservoir projects, but it did not include construction of a new storage reservoir.

Table 3.13—Operations model input for annual consumptive demands (acre-feet) in study area

Location	Current conditions	No Action	LWSA	TROA
Agricultural demand in California				
Truckee River basin	1,800	2,100	2,100	2,100
Agricultural demands in Nevada				
Truckee Meadows	40,770	21,500	21,500	4,860
Newlands Project: Truckee Division	18,520	[1]0	[1]0	[1]0
Newlands Project: Carson Division[2]	275,720	268,870	268,870	268,870
Lower Truckee River	12,040	17,900	17,900	17,900
M&I demands in California				
Lake Tahoe basin	18,700	23,000	23,000	23,000
Truckee River basin	8,570	20,600	20,600	20,600
M&I demands in Nevada				
Lake Tahoe basin	[3]11,000	11,000	11,000	11,000
Truckee Meadows (TMWA) Normal[4]	83,140	119,000	119,000	119,000
Truckee Meadows (TMWA) Drought	83,140	107,300	109,200	113,720
Tracy hydroelectric powerplant[5]	1,950	3,500	3,500	3,500
Washoe County[6]	9,900	21,750	21,750	21,750
Fernley	[7]0	[8]6,800	[8]6,800	[8]6,800
Pyramid Lake Indian Reservation	[9]0	[10]16,380	[10]16,380	[10]16,380
Out-of-basin exports in California				
To Sierra Valley	7,000	7,000	7,000	7,000
To South Fork of American River	2,000	2,000	2,000	2,000
To Carson River[11]	4,100	4,700	4,700	4,700
Out-of-basin exports in Nevada				
To Carson River[12]	5,000	6,500	6,500	6,500
To Stead (supplied by TMWA)	1,680	1,680	1,680	1,680

[1] Assumes all Truckee Division water rights are acquired and transferred for WQSA and local M&I, although some agricultural rights are likely to remain in the future.
[2] The Carson River supplies a majority of this demand; the Truckee River provides only a supplemental supply.
[3] This was the assumed demand when the operations model was run; recent information indicates it is 9,379 acre-feet.
[4] TMWA's normal water supplies, as defined in the Negotiated Agreement, are the water sources that TMWA ordinarily uses in the absence of a drought to meet its customer M&I demands.
[5] Modeled as depletion (i.e., no return flows).
[6] Washoe County is served through groundwater or the consumptive use of tributary rights and is only indirectly input into the model in the Truckee Meadows depletions.
[7] Current demand of 3,280 acre-feet supplied by local groundwater sources.
[8] Transfer of 6,800 acre-feet of Truckee Division agricultural water rights would provide a portion of the future Fernley demand of 29,500 acre-feet; the source of the 22,700-acre-foot difference is neither identified nor modeled.
[9] Current demand of 1,120 acre-feet supplied by local groundwater sources.
[10] Includes portions of full exercise of Claim Nos. 1 and 2 of the *Orr Ditch* decree. See attachment G.
[11] Sewage effluent from South Tahoe Public Utility District.
[12] Sewage effluent from Incline Village General Improvement District, Douglas County Sewer Improvement District No. 1, and diversions from Marlette Lake.

Because TMWA has not proposed construction of a reservoir and a facility is not proposed under No Action, LWSA, or TROA, this study did not analyze a new reservoir component.

(i) Consumptive Demands

aa. Agriculture

In the future, surface water would continue to meet agricultural demand in the Truckee River basin. Agricultural demand in the Truckee River basin in California is projected to increase by 300 acre-feet. Agricultural demand in the Truckee River basin in Nevada is projected to decrease from 40,770 acre-feet per year under current conditions to 21,500 acre-feet per year under No Action as a result of urbanization. Agricultural demand in the Truckee Division is projected to decrease from 18,520 acre-feet per year under current conditions to 0 acre-feet per year in the future. The cities of Reno and Sparks, Washoe County, and the Federal Government are projected to acquire approximately 10,300 acre-feet of agricultural surface water rights from the Truckee Division and 2,400 acre-feet from the Truckee River basin for water quality purposes, pursuant to WQSA.

Fernley is projected to acquire for M&I use agricultural water rights from the Truckee Division not acquired for WQSA, and TMWA is projected to acquire for M&I use agricultural surface water rights in the Truckee River basin.

Future Carson Division demand is projected to be less than current because of the purchase of water rights under the Water Rights Acquisition Program for Stillwater National Wildlife Refuge (WRAP). Water rights currently being purchased under WRAP (bottom and bench land with respective duties of 3.5 and 4.5 acre-feet per acre per year) are transferred to the wetlands at 2.99 acre-feet per acre per year. The operations model assumes that, under current conditions, 21,300 acre-feet of water rights are dedicated to the wetlands and that, under the alternatives, FWS would continue to purchase and transfer (at the reduced rated of 2.99 acre-feet per acre per year) an additional 41,600 acre-feet of water rights to the wetlands by 2033. As a result, the Carson Division demand decreases from 275,720 acre-feet under current conditions to 268,870 acre-feet under the alternatives. The goal of WRAP is to transfer 125,000 acre-feet of water to the wetlands, 60,000 to 64,000 acre-feet of which would be purchased Carson Division water rights. The additional water is assumed to be provided by 19,700 acre-feet of drainage; 9,700 acre-feet of spills and 33,600 acre-feet comprised of upstream Carson River water rights, groundwater, Navy conservation, and other sources.

Lower Truckee River agricultural demand is expected to increase from the current 12,040 to 17,900 acre-feet per year; demand would be through the exercise of Claim Nos. 1 and 2 of the *Orr Ditch* decree and other water rights.

bb. M&I

In California, total M&I demand is projected to increase from 27,270 to 43,600 acre-feet per year; groundwater is expected to primarily meet the increased demand. Demand in the Lake Tahoe basin is expected to increase from 18,700 to 23,000 acre-feet per year, while demand in the Truckee River basin is expected to increase from 8,570 to 20,600 acre-feet per year. The surface water component of the Truckee River basin demand is projected to remain at 1,000 acre-feet per year.

Exports of water from the Truckee River basin are projected to be greater than under current conditions (6,500 acre-feet compared to 5,000 acre-feet).

In Nevada, M&I demand in the Lake Tahoe basin is expected to remain at 11,000 acre-feet per year. Total Nevada M&I demand in the Truckee River basin is projected to increase from approximately 99,400 to 190,100 acre-feet per year because of population increases, primarily in Truckee Meadows. In Truckee Meadows, M&I demand is projected to increase from 83,140 to 119,000 acre-feet per year. To meet the increased demand, TMWA is expected to acquire additional Truckee Meadows agricultural water rights, for a total of 83,030 acre-feet of surface water rights.

Groundwater would be operated conjunctively with other supplies to meet M&I demands. As modeled, when less than a full water supply is available (in dry years), conservation measures are implemented and surface water supplies are supplemented by additional groundwater pumping.

Tracy hydroelectric powerplant demand is projected to increase from 1,950 to 3,500 acre-feet per year. Fernley M&I demand is projected to increase from 3,610 to 29,500 acre-feet per year, and the Pyramid Tribe's demand is projected to increase from 1,120 to 16,380 acre-feet per year. Transfer of 6,800 acre-feet of Truckee Division agricultural water rights would provide a portion of the future Fernley demand of 29,500 acre-feet; the source of the 22,700-acre-foot difference is neither identified nor modeled.

(ii) Nonconsumptive Demands

As previously discussed, the cities of Reno and Sparks, Washoe County, and the Federal Government are expected to acquire agricultural surface water rights from the Truckee River basin for water quality purposes, pursuant to WQSA. Also, under TROA, the cities of Reno and Sparks and Washoe County agree to provide an additional 6,700 acre-feet of existing Truckee Meadows water rights.

As of March 2006, approximately 4,470 acre-feet of surface water rights had been acquired in the Truckee Division pursuant to WQSA. On the basis of water rights available, current pricing, and inflation for the duration of the program, it is estimated that a total of 10,311 acre-feet in the Truckee Division, 1,500 to 2,000 acre-feet of *Orr Ditch* water rights between Vista and Wadsworth, and 900 acre-feet in the Truckee Meadows could be purchased under WQSA. The basis of this estimate is presented in the Water Resources Appendix, Exhibit 17. These water rights would be used to improve Truckee River water quality by increasing flows from June through September to meet flow targets and, consequently, enhancing the river's capacity to assimilate nutrients. Water quality flow targets at Sparks and Nixon are shown in chapter 2.

Minimum and hydroelectric power bypass flows and recreational pool targets would be the same as under current conditions. Pyramid Lake fish flows would be selected using the same criteria as under current conditions.

(c) LWSA Modeled Demands

Total consumptive and nonconsumptive demands under LWSA would be the same as under No Action, except that California's Truckee River M&I surface water component would increase from 1,000 acre-feet per year under No Action to 2,200 acre-feet per year under LWSA, and the groundwater component would decrease by 1,200 acre-feet per year. For modeling purposes, California's additional surface water demand is assumed to be diverted from the Truckee River just downstream from the confluence with Donner Creek. TMWA would exercise its water rights to provide an additional 1,000 acre-feet per year to groundwater recharge; under LWSA, groundwater pumping under drought conditions would be 26,500 acre-feet compared to 22,000 acre-feet per year under No Action. As under No Action, the operations model assumes that conservation measures would be implemented only in dry years. Modeled operations are the same as under No Action.

(d) TROA Modeled Demands

Flood control and dam safety requirements and existing water rights would be served as under current operations. Under TROA, signatories would have the opportunity to store and exchange Credit Water. See the Water Resources Appendix, Exhibit 16, for a detailed discussion of Credit Water operations and examples of operations model calculations.

The operations model uses similar demands for TROA as for No Action, as follows.

(i) Consumptive Demands

aa. Agriculture

As shown in table 3.13, the operations model assumes that, under TROA, agricultural demand in the Truckee River basin in California is the same as under LWSA and that agricultural demands in the lower Truckee River and the Newlands Project are the same as under No Action. However, under TROA, TMWA is expected to acquire and transfer more Truckee Meadows agricultural water rights to M&I use than under the No Action. Because TROA would require 1.11 acre-feet of water rights for every acre-foot of new service commitment (versus 1 acre-foot per acre-foot of commitments under No Action and LWSA), TMWA projects that a total of 93,550 acre-feet of agricultural rights would be acquired. The remaining 0.11 acre-foot would be used to accumulate TMWA M&I Credit Water. (See page 6 of attachment C for detailed explanation.)

bb. M&I

Under TROA, future populations in the Lake Tahoe and Truckee River basins in California are projected to be the same as under No Action. P.L. 101-618 limits Lake Tahoe basin water use by both California and Nevada to 23,000 and 11,000 acre-feet per year, respectively. See Section III, "Study Assumptions," in "General Methods and Assumptions" for more information about the development of population projections.

The operations model assumes that under TROA, total Nevada M&I demand during a normal water year[3] in the Truckee River basin is the same as under No Action. See table 3.13. TMWA's demand in Truckee Meadows is projected to be 119,000 acre-feet per year, securing a total of 93,550 acre-feet of Truckee Meadows agricultural water rights. Under TROA, storage of surplus TMWA diversion rights and TMWA Private Water released from Donner and Independence Lakes is required to provide drought supplies.

TMWA may store an unlimited amount of TMWA M&I Credit Water before April 1. In a drought year, this water may be used to meet M&I demand.

In a non-drought year, TMWA would be permitted to store up to a maximum 20,000 acre-feet on April 1 as Non-Firm TMWA M&I Credit Water when TMWA's normal year demand is 119,000 acre-feet and California's depletion in the Truckee River basin is 16,000 acre-feet per year. Under TROA, the operations model assumes a California depletion of 11,610 acre-feet per year. (See detailed computations in the Water Resources Appendix, Exhibit 18.) This depletion limits the Non-Firm TMWA M&I Credit Water to 16,630 acre-feet per year when TMWA's normal year demand is 119,000 acre-feet. Under TROA (and as modeled) TMWA would be permitted to store a maximum of 12,000 acre-feet as Firm TMWA M&I Credit Water. TMWA Emergency Credit Water of 7,500 acre-feet also would be established.

The operations model uses TMWA M&I Credit Water conjunctively with other supplies to meet demands in drought situation. TMWA would be required to implement conservation measures in a drought situation. If TMWA's normal water supplies and releases of Private Water from Donner Lake are not sufficient to meet these reduced demands and Independence Private Water is less than 7,500 acre-feet, then Non-Firm TMWA M&I Credit Water, followed by Firm TMWA M&I Credit Water, could be released. When a drought situation exists, Non-Firm TMWA M&I Credit Water in excess of the base amount would be retained for use later in that year.

The operations model assumes that Fernley and Pyramid Lake Indian Reservation M&I demands under TROA are the same as under No Action. Under both No Action and TROA, Fernley is assumed to purchase surface water rights in the Truckee Division. Fernley would have an opportunity to store any excess surface water rights as Credit Water under TROA. Because no terms for storage have been agreed to, however, the operations model includes no such Credit Waters and exercises all acquired Fernley water rights to meet immediate demands. (A separate analysis considered the potential effects of Fernley storage as well as the potential effects of TMWA's acquisition of TCID's portion of Donner Lake storage. See Section H, "Optional Scenarios.")

The operations model assumes that California and Nevada M&I demands in the Lake Tahoe basin and California M&I demand on the Truckee River under TROA are the same as under No Action. The operations model assumes that under TROA, California is

[3] TMWA's normal water supplies, as defined in the Negotiated Agreement, are the water sources that TMWA ordinarily uses in the absence of a drought to meet its customer M&I demands.

allowed to store as much as 8,000 acre-feet each year as California M&I Credit Water to supply its M&I surface water diversions later in the year. The storage is accumulated in Lake Tahoe by reducing releases that would otherwise be made and allocating water associated with a water right from the Truckee River downstream from Lake Tahoe to replace the water that would otherwise have been released from Lake Tahoe. By exchange, California water stored in Lake Tahoe may be transferred to another Truckee River reservoir, but only a maximum of 3,000 acre-feet of the 8,000 total could be held outside of Lake Tahoe. Accumulation of California M&I Credit Water is further restricted in the operations model to no more than 25 percent of the annual entitlement in any one month. TROA would allow new facilities to be built in California, but space for California M&I Credit Water in Federal reservoirs would be reduced for any amount over 2,500 acre-feet. The operations model does not simulate operation of any new California storage facilities. Exports from the Truckee River basin are projected to be the same as under No Action. TROA also would allow imported water to be stored as Credit Water. The operations model does not simulate any specific import proposal.

(ii) Nonconsumptive Demands

The operations model assumes that, under TROA, nonconsumptive demands on the Truckee River for hydroelectric power generation, lower Truckee River flows, and minimum reservoir releases, except from Independence Lake and Prosser Creek Reservoir, are the same as under No Action. In addition, the operations model incorporates new minimum releases from Independence Lake and Prosser Creek Reservoir, revised hydroelectric powerplant bypass requirements, preferred and enhanced minimum flow targets, and recreational pool targets. Revised minimum Prosser Creek Reservoir releases are 5 cfs, and Independence Lake minimum releases are computed using the criteria discussed in chapter 2. All hydroelectric powerplant diversion dams on the Truckee River are modeled to bypass a minimum of 50 cfs, or total streamflow immediately upstream of the diversion dam, whichever is less. Additionally, up to 150 cfs of fish water can be bypassed from May through September, for a total bypass of 200 cfs, and up to 50 cfs of fish water can by bypassed from October through April, for a total bypass of 150 cfs. A detailed discussion of this operation is presented in "Minimum Bypass Flow Requirements for TMWA's Hydroelectric Diversion Dams on the Truckee River."

The operations model uses seasonal forecasts to select reservoir releases when flows greater than the minimum can be maintained. These releases do not include Floriston Rate Water unless it is being released for the exercise of *Orr Ditch* decree water rights. Releases are selected with a "most desirable" target[4] based upon preferred flows established by CDFG and incorporated in the Sample California Guidelines (Exhibit D of the attachment to chapter 2). Although California Guidelines are not mandatory, the

[4] The most desirable target is the largest flow that can be maintained between minimum and preferred flow targets during a certain period and at a certain location without interfering with water rights of others. This flow is also adjusted according to streamflows, reservoir storage, and other environmental objective priorities established in California Guidelines.

Administrator would encourage signatory parties to TROA to consider the guidelines in their scheduling consistent with their water rights and provisions of TROA. Therefore, the operations model uses the preferred releases presented in table 3.14.

Table 3.14—Preferred reservoir releases used in the operations model (cfs)

Reservoir	Oct–Jan	Feb–Mar	Apr–Jul	Aug–Sep
Lake Tahoe	250	150	300	150
Donner Lake	50	20	50	10
Prosser Creek Reservoir	50	35	75	30
Independence Lake	20	10	20	10
Stampede Reservoir	125	100	125	100
Boca Reservoir	N/A	N/A	N/A	N/A

The operations model procedure for establishing most desirable targets varies by month, as follows:

- *October through January*: Release targets are adjusted to equal minimum flows.
- *February through May*: The capacity to make releases between the minimum and preferred through June is calculated; the release targets are adjusted each month based on the updated forecast.
- *June*: Release targets are the minimums because operations provide releases greater than the minimums.
- *July through September*: Release targets are based on scheduled release through October in conjunction with the minimum and preferred flows.

The operations model uses the recreational pool targets for May through August that are based on Sample California Guidelines, as presented in table 3.15, as targets.

Table 3.15—Recreational pool targets (acre-feet) used in the operations model

Lake Tahoe	None
Donner Lake	8,800
Prosser Creek Reservoir	19,000
Independence Lake	10,500
Stampede Reservoir	127,000
Boca Reservoir	33,500

California has the option under TROA to exercise additional surface water rights, which may be used to accumulate California M&I Credit Water. For this analysis, it was assumed that California would increase diversion demand by 1,200 acre-feet and exercise an additional 300 acre-feet of rights per year to establish California M&I Credit storage Up to 8,000 acre-feet could be stored at any time. California water stored in Lake Tahoe may be exchanged to another Truckee River reservoir.

Under TROA, a portion of Fish Credit Water would be designated as Joint Program Fish Credit Water (JPFCW). The total amount of JPFCW in storage at any time in the Truckee River reservoirs cannot exceed 20,000 acre-feet. In the operations model, JPFCW is transferred among reservoirs with an objective of maintaining recreation pools. When no other supplies are available, JPFCW is used to maintain minimum releases.

Some of the operations provided for under TROA are not modeled because projects have not been identified, approvals have not been secured, or implementation would depend on uncertain environmental variables. Such operations include:

- Storage of imported water in Truckee River reservoirs as Other Credit Water
- Water-related emergencies
- Maintenance of a dam or other water or power facility
- Pumping of Sparks Marina Lake
- Release of water for removal of ice from hydropower facilities and Highland Ditch
- Pumping of Lake Tahoe or Independence Lake
- Construction of a new water storage facility
- Transfer of *Sierra Valley* decree water rights to Truckee River basin
- Additional California Environmental Credit Water
- Use of water for snowmaking
- Storage and release of Other Credit Water
- Design of water wells in the Truckee River basin in California

2. Model Results and Evaluation of Effects

Water stored in and released from reservoirs are indicators of the water supply to meet demands and serve a number of beneficial uses. Total end-of-month reservoir storage, individual end-of-month reservoir storage, and average monthly reservoir releases are presented as shown in table 3.16.

Table 3.16—Figures showing reservoir storages and releases

Storage facility	Storage	Releases
Total	Figure 3.3	N/A
Lake Tahoe	Figure 3.4	Figure 3.5
Donner Lake	Figure 3.6	Figure 3.7
Prosser Creek Reservoir	Figure 3.8	Figure 3.9
Independence Lake	Figure 3.10	Figure 3.11
Stampede Reservoir	Figure 3.12	Figure 3.13
Boca Reservoir	Figure 3.14	N/A
Lahontan Reservoir	Figure 3.15	Figure 3.16

Figures listed in table 3.16 are reproduced in larger format in the Water Resources Appendix, Exhibit 19.

a. Current Conditions

(1) Total Reservoir Storage

Operations model results show that, under current conditions, total reservoir storage is fairly constant from October through February, when flood control criteria may restrict storage. The reservoirs fill from March through June with spring runoff and snowmelt; releases to meet water demands are made year-round but are greatest from June through September. In wet hydrologic conditions, total end-of-month reservoir storage ranges from a minimum of approximately 871,000 acre-feet in November to a maximum of 1,056,000 acre-feet in July. In median and dry hydrologic conditions, minimum storage occurs in December and maximum storage normally occurs in June. Storage ranges from 689,000 to 951,000 acre-feet in median hydrologic conditions and 29,000 to 148,000 acre-feet in dry hydrologic conditions. See figure 3.3.

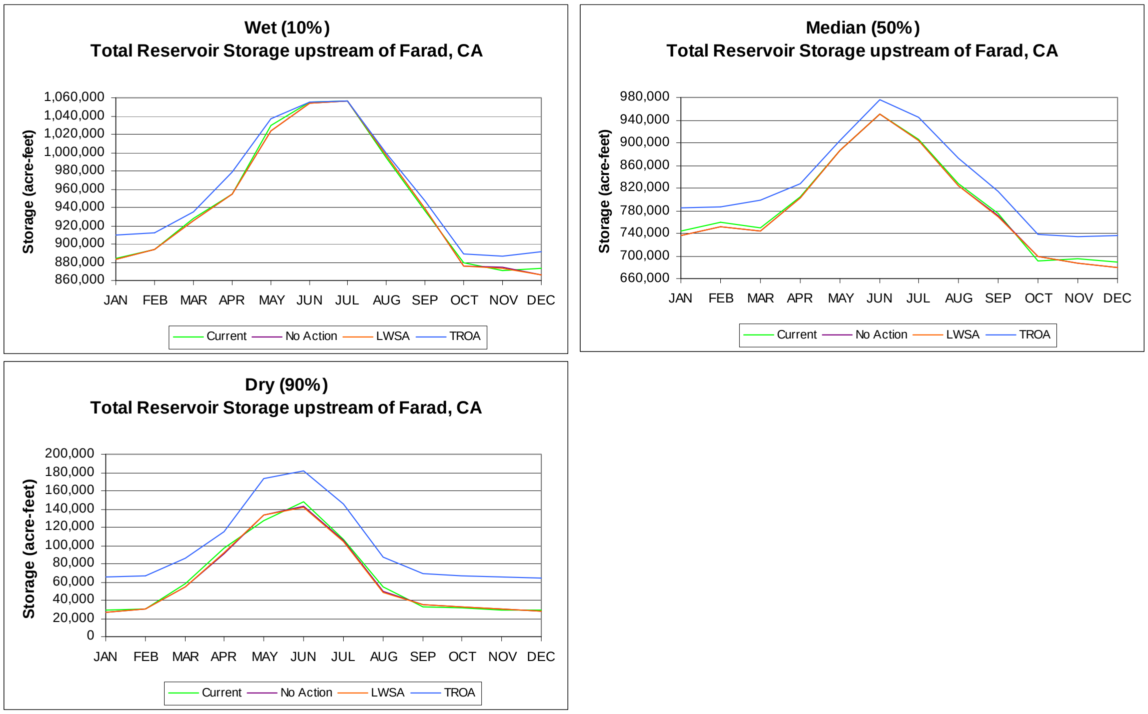


Figure 3.3—Operations model results for total end-of-month reservoir storage.

(2) Lake Tahoe

Lake Tahoe accounts for about 70 percent of the total reservoir storage space in the Truckee River system. Operations model results show that, under current conditions, Lake Tahoe storage ranges widely, from a maximum of 732,000 acre-feet in wet hydrologic conditions to a minimum of –30,700 acre-feet in dry hydrologic conditions (figure 3.4). (Note: Negative storage indicates the lake is below its natural rim elevation of 6223 feet; releases cannot be made when storage is negative.)

Lake Tahoe releases are shown in figure 3.5. In wet hydrologic conditions, releases are made during the winter to ensure that lake does not exceed elevation 6229.1 feet (storage of 732,000 acre-feet) and during the summer to meet streamflow requirements. The maximum monthly release is 3,030 cfs, and the minimum is 0 cfs.

(3) Donner Lake

Operations model results show that, under current conditions, Donner Lake storage available to TCID and TMWA ranges from a maximum of 9,500 acre-feet from May to August in wet hydrologic conditions to a minimum of 2,890 acre-feet from November through February in dry hydrologic conditions (figure 3.6). In May, Donner Lake fills in both wet and median hydrologic conditions. Storage available to TCID and TMWA reaches only 8,300 acre-feet in dry hydrologic conditions.

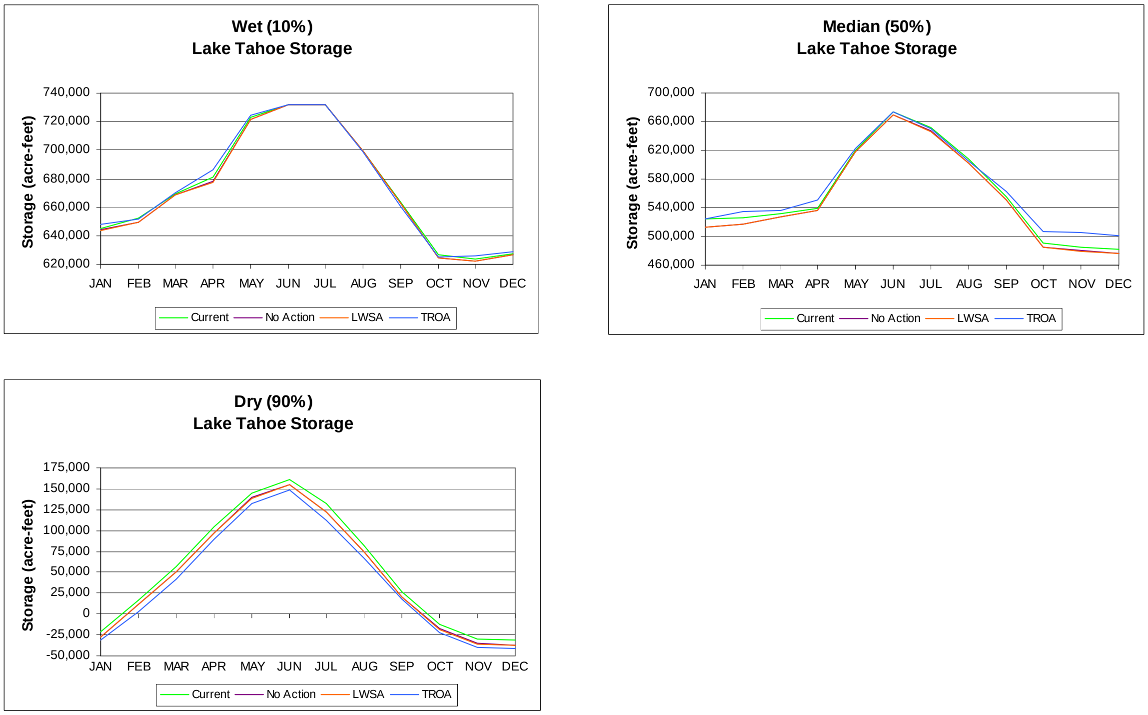


Figure 3.4—Operations model results for Lake Tahoe end-of-month storage.

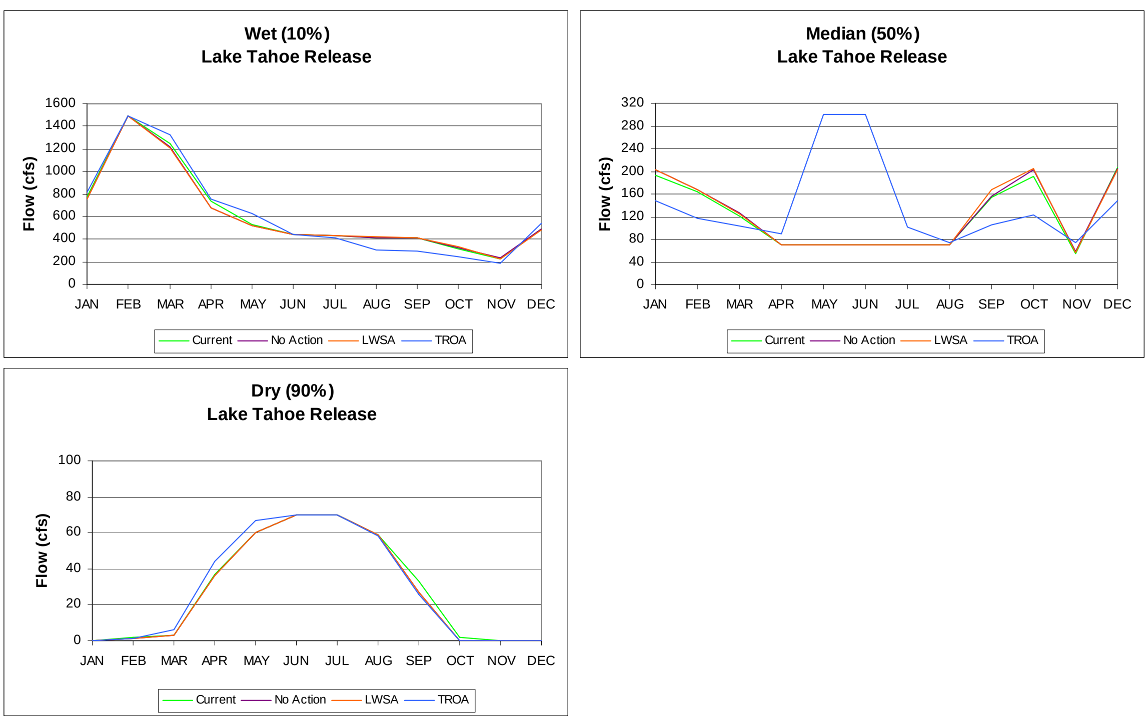


Figure 3.5—Operations model results for Lake Tahoe average monthly releases.

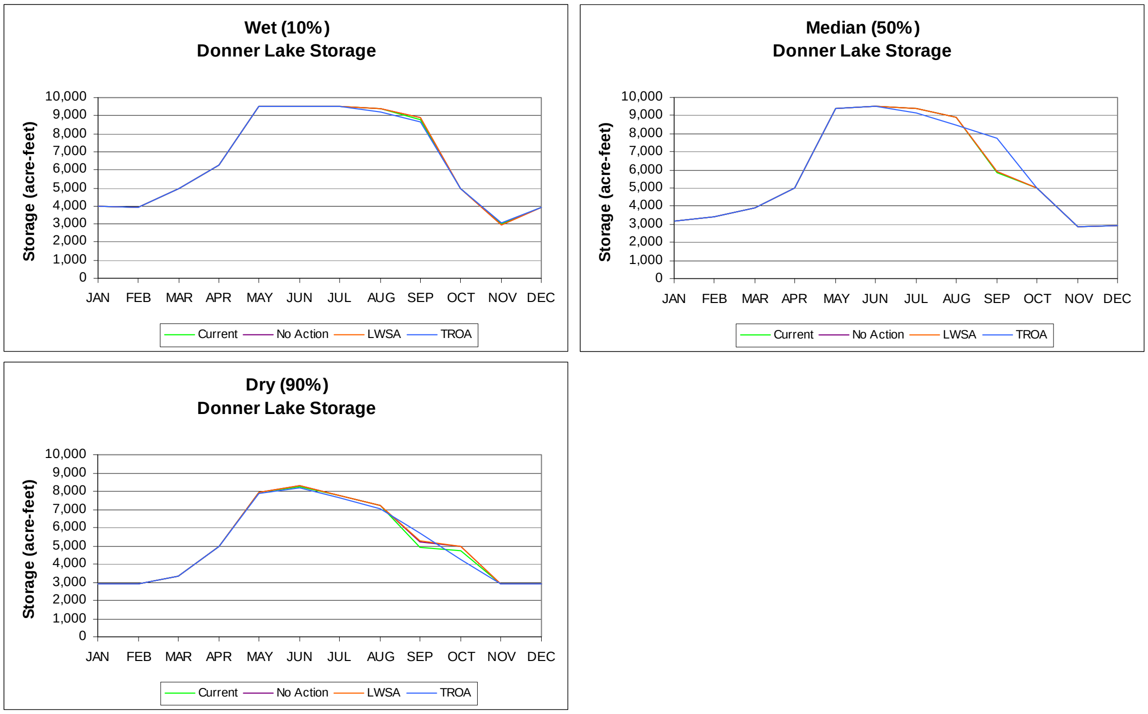


Figure 3.6—Operations model results for Donner Lake end-of-month storage.

Operations model results show a similar pattern of releases in median and dry hydrologic conditions (figure 3.7); releases are restricted to minimums from July through August to maintain storage for releases to meet demands in September and to meet the Donner Lake Indenture minimum elevation. A maximum average monthly release of 140 cfs occurs from May through June in wet hydrologic conditions, and a minimum of 2 cfs occurs from June through August in dry hydrologic conditions. The "spike" in October and November releases is the result of evacuating storage by opening the two lower gates by November 15. Gravity releases at or below this storage are not possible. In wet hydrologic conditions, reservoir storage from December through February is about 4,000 acre-feet because even though the gates are open, the outlet is restricted and inflows are greater than the outlet's capacity to make releases.

(4) Prosser Creek Reservoir

Operations model results show that, under current conditions, Prosser Creek Reservoir storage ranges from a maximum of 29,800 acre-feet in June in wet hydrologic conditions to a minimum of 1,600 acre-feet from July through February in dry hydrologic conditions

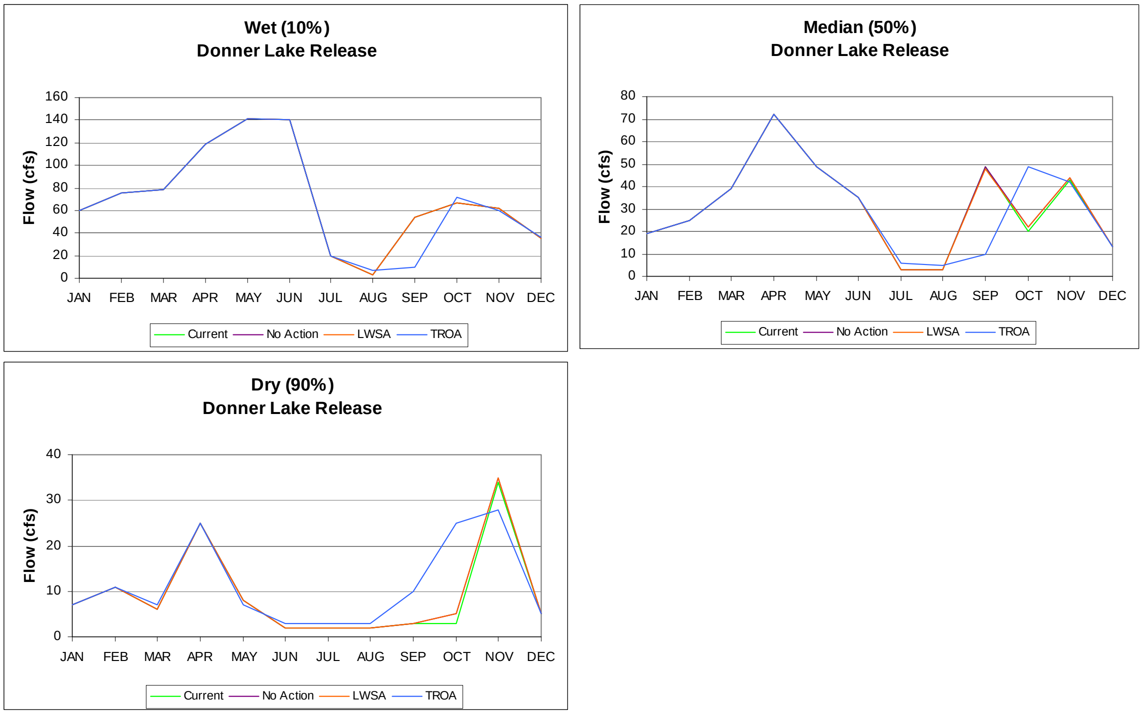


Figure 3.7—Operations model results for Donner Lake average monthly releases.

(figure 3.8). In wet and median hydrologic conditions, the reservoir stores water in excess of Floriston Rate requirements and subject to TPEA from April through June. Storage declines from June through October as releases are made to meet demands and as TPEA water is released to meet Floriston Rates. Releases are made to lower storage to 9,800 acre-feet from October through March to meet flood control requirements. In dry hydrologic conditions, reservoir storage reaches a maximum of 9,000 acre-feet. Storage in median and dry hydrologic conditions is 76 and 16 percent of that in wet hydrologic conditions, respectively.

Generally, water is passed through Prosser Creek Reservoir from March through June to meet Floriston Rates and Newlands Project demands. Project Water is released to enhance spawning of Pyramid Lake fishes from June through October; Tahoe-Prosser Exchange Water is released from June through August. In wet hydrologic conditions, maximum releases are 500 cfs in May; in dry hydrologic conditions, maximum releases are 50 cfs. Minimum releases are made from July through the following February in dry hydrologic conditions as storage approaches minimum. See figure 3.9.

(5) Independence Lake

Operations model results show that, under current conditions, Independence Lake storage ranges from a maximum of 17,200 acre-feet from June through August in wet hydrologic conditions to a minimum of 13,800 acre-feet in dry hydrologic conditions, November to

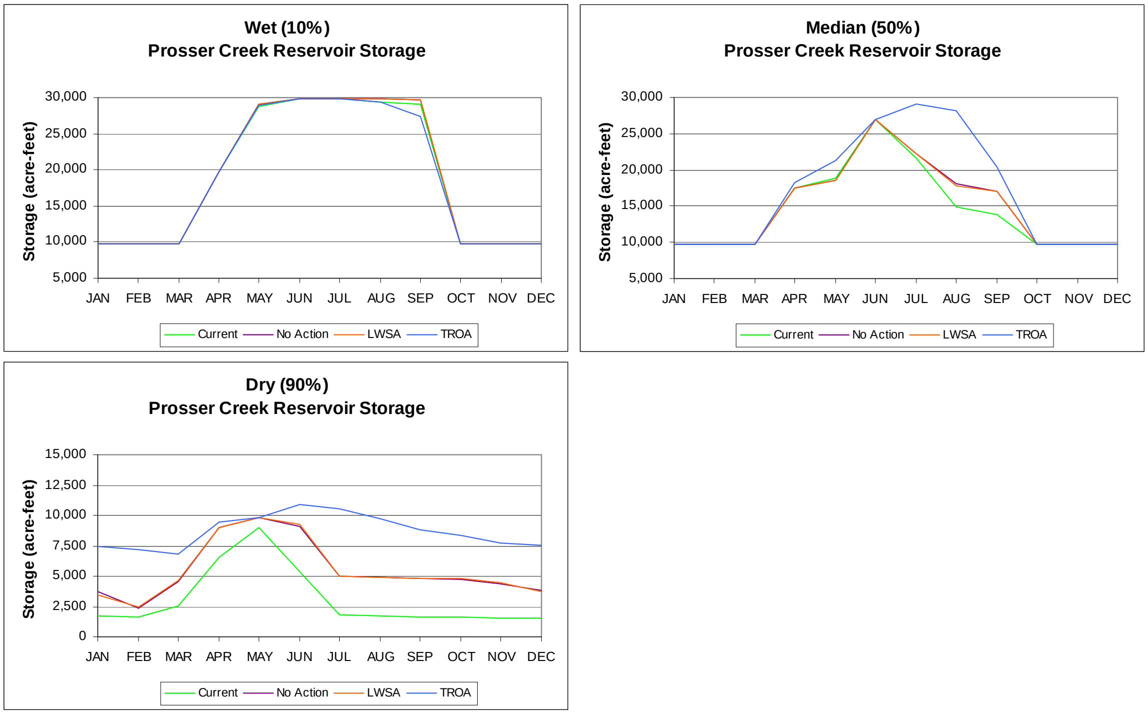


Figure 3.8—Operations model results for Prosser Creek Reservoir end-of-month storage.

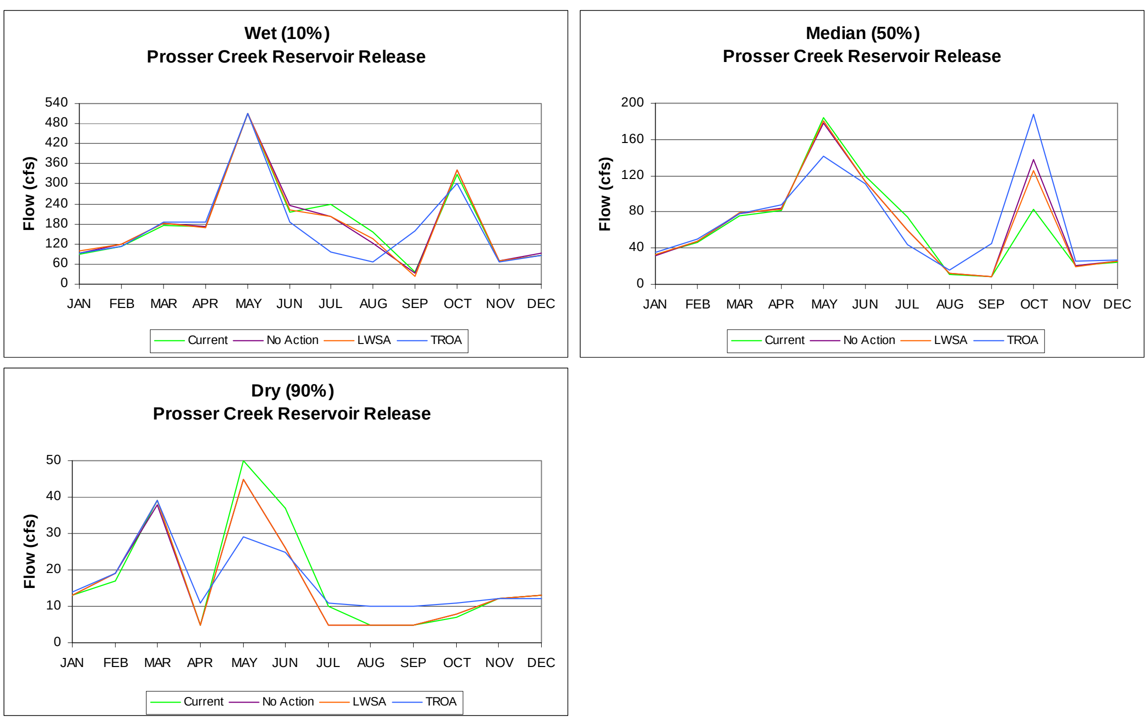


Figure 3.9—Operations model results for Prosser Creek Reservoir average monthly releases.

January (figure 3.10). Operations model results show similar storage and release patterns in all hydrologic conditions. Flashboards must be removed from two of the bays in the spillway structure between November 1 and April 1 of the following year; in general, storage in Independence Lake is maintained at 14,500 acre-feet during the winter. The reservoir fills from April through June, and releases are generally equal to inflow until August. Storage in median and dry hydrologic conditions is 99 and 95 percent of that in wet hydrologic conditions, respectively. Independence Lake storage tends to be held in reserve to meet Truckee Meadows M&I demand in water-short years.

Releases to meet Truckee Meadows M&I demand are normally made from August through October. A maximum of 105 cfs is released in June in wet hydrologic conditions, and a minimum of 2 cfs is released from July through September in dry hydrologic conditions. Minimum flows are met in all months. Figure 3.11 shows Independence Lake releases.

(6) Stampede Reservoir

Operations model results show that, under current conditions, storage ranges from a maximum of 226,500 acre-feet in July in wet hydrologic conditions to a minimum of 12,900 acre-feet in December and January in dry hydrologic conditions (figure 3.12). In all three hydrologic conditions, the reservoir stores between March and May. Flow targets are set for the lower Truckee River for each month of the year based on reservoir storage and forecast seasonal reservoir inflow. When these targets are not met, releases are made to increase flows in the lower Truckee River to meet the targets. In wet hydrologic conditions, releases are made from October to March to avoid exceeding maximum reservoir storage of 204,500 acre-feet. Storage in median and dry hydrologic conditions is 85 and 10 percent of that in wet hydrologic conditions, respectively.

Generally, releases are made from March through July to pass through water for Floriston Rates and to enhance Pyramid Lake fish spawning in the lower Truckee River. As noted previously, lower Truckee River flow targets for the remainder of the year are met with Stampede Reservoir release of Project Water when necessary. Maximum releases of 900 cfs are made in May in wet hydrologic conditions, and minimum releases of 30 cfs are made from August through the following February in dry hydrologic conditions. Figure 3.13 shows Stampede Reservoir releases.

(7) Boca Reservoir

Operations model results show that Boca Reservoir storage ranges from a maximum of 40,900 acre-feet from May through July in wet hydrologic conditions to no storage from December through the following March in dry hydrologic conditions (figure 3.14). Generally, water is stored from November to May. Releases are made to meet Floriston Rates and to pass Stampede Reservoir releases from March through September. Storage in median and dry hydrologic conditions is 59 and 10 percent of that in wet hydrologic conditions, respectively.

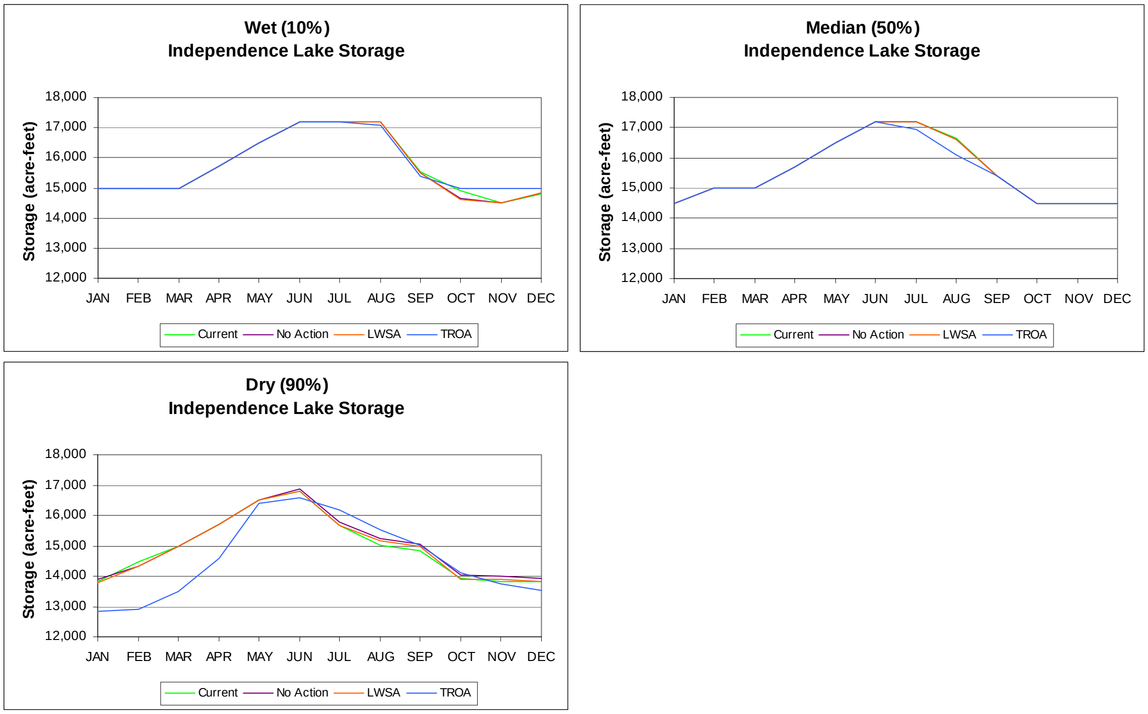


Figure 3.10—Operations model results for Independence Lake end-of-month storage.

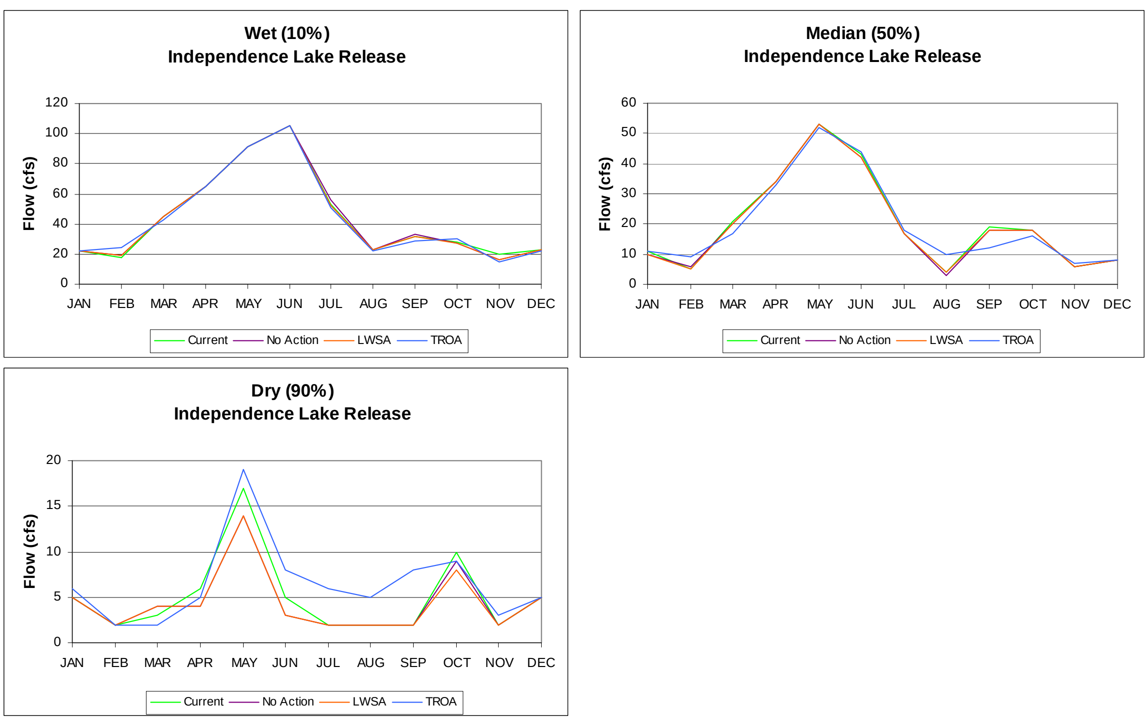


Figure 3.11—Operations model results for Independence Lake average monthly releases.

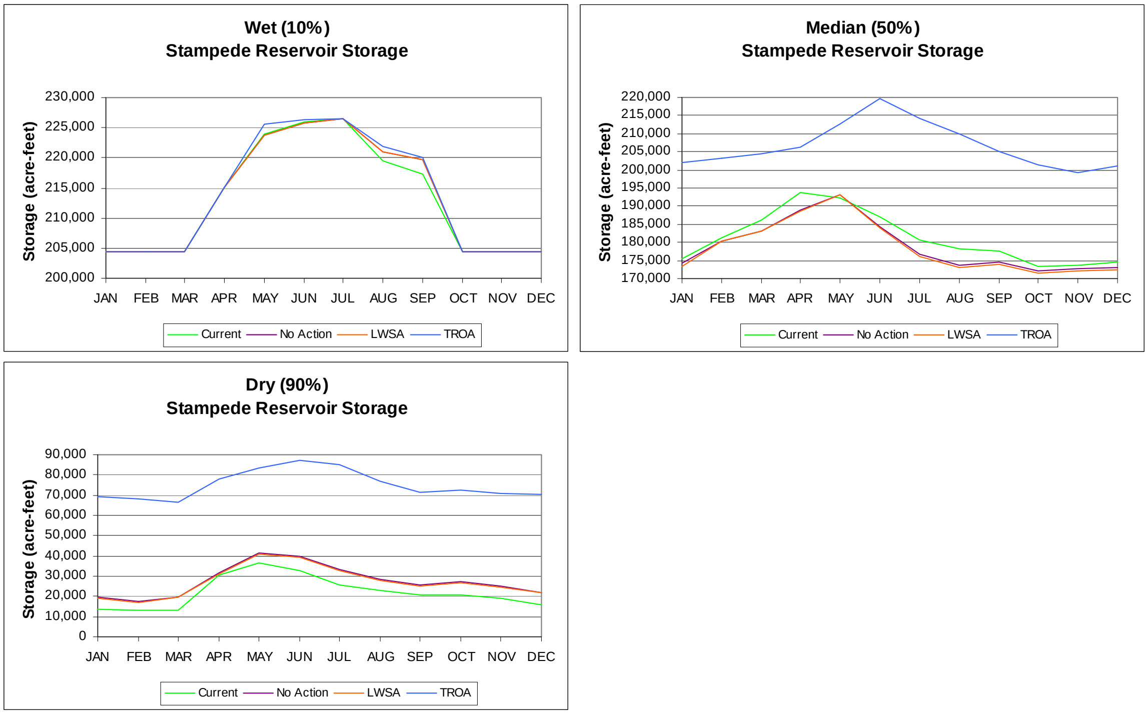


Figure 3.12—Operations model results for Stampede Reservoir end-of-month storage.

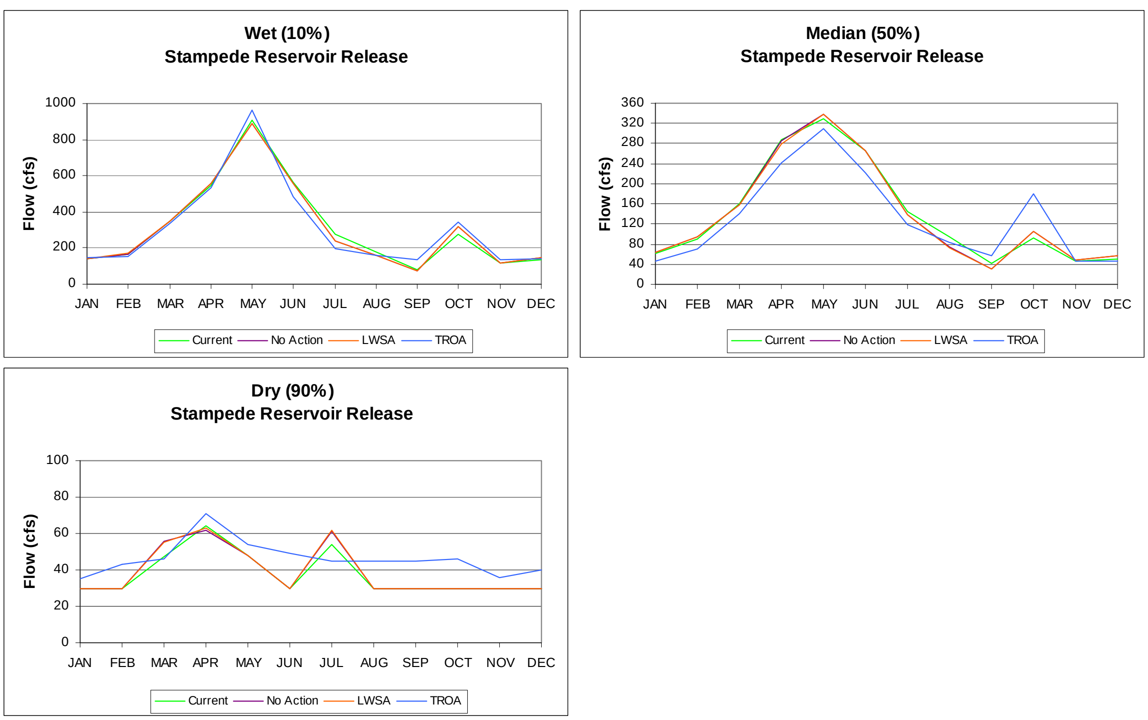


Figure 3.13—Operations model results for Stampede Reservoir average monthly releases.

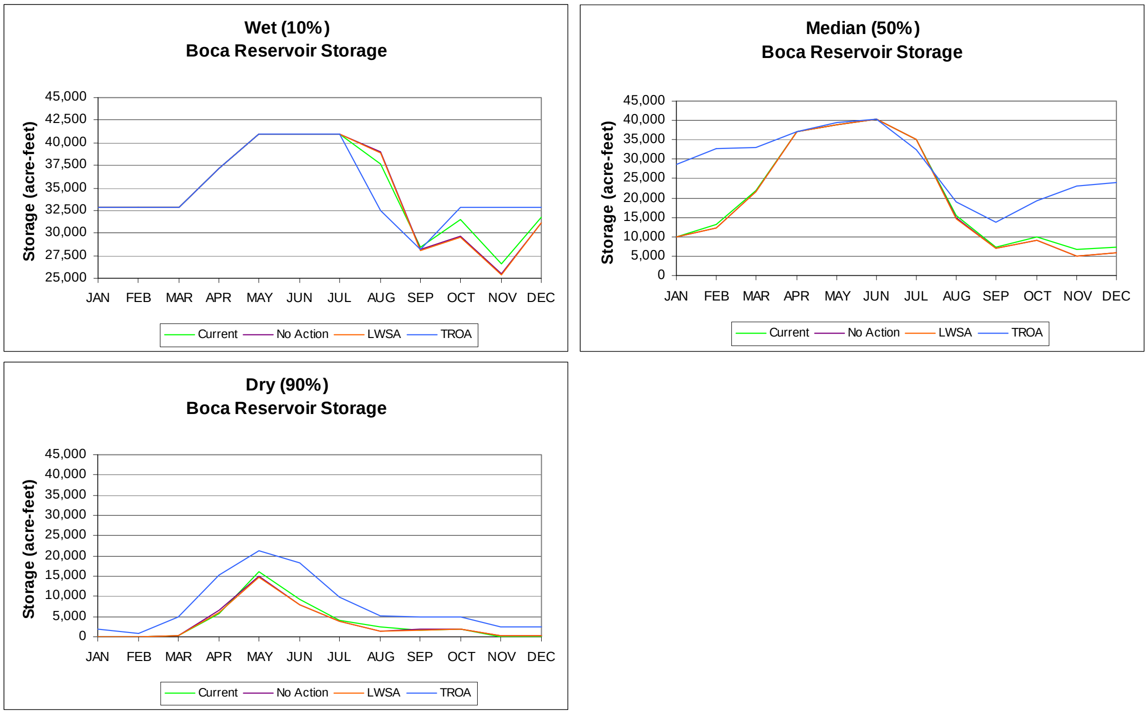


Figure 3.14—Operations model results for Boca Reservoir end-of-month storage.

Releases from Boca Reservoir are highly variable because of Stampede Project Water operations and cannot be characterized for wet, median, and dry hydrologic conditions. Probabilities of exceedence values for Boca Reservoir releases are not indicative of the hydrologic conditions and were not evaluated as such.

(8) Lahontan Reservoir

Reservoir storage patterns at Lahontan Reservoir are very similar in all hydrologic conditions (figure 3.15). Maximum storage in wet hydrologic conditions is 316,900 acre-feet; minimum storage in dry hydrologic conditions is 31,200 acre-feet. Storage in median and dry hydrologic conditions is 58 and 36 percent of that in wet hydrologic conditions, respectively.

In wet hydrologic conditions, releases are made from February through June to avoid downstream flooding and from July to November to meet downstream demands. In median and dry hydrologic conditions, releases are made from March through November to meet Carson Division demands. In all three hydrologic conditions, Carson Division demands are met, and the release pattern is the same in median and dry hydrologic conditions. No releases are made from December to February. Figure 3.16 shows Lahontan Reservoir releases.

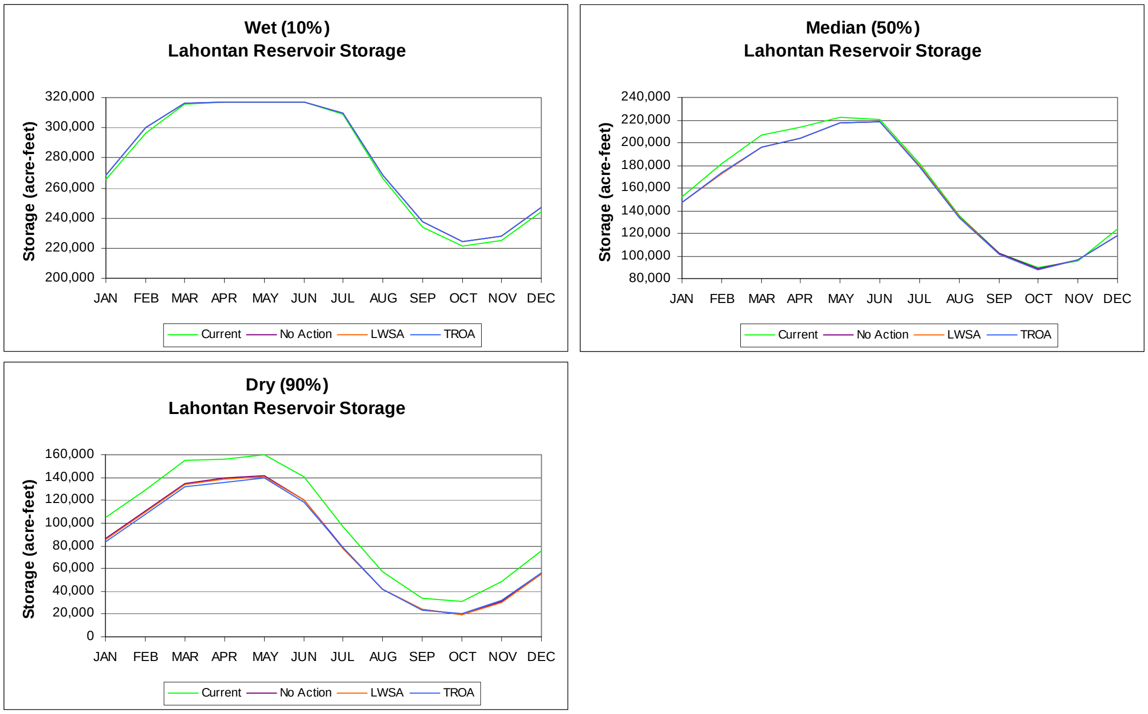


Figure 3.15—Operations model results for Lahontan Reservoir end-of-month storage.

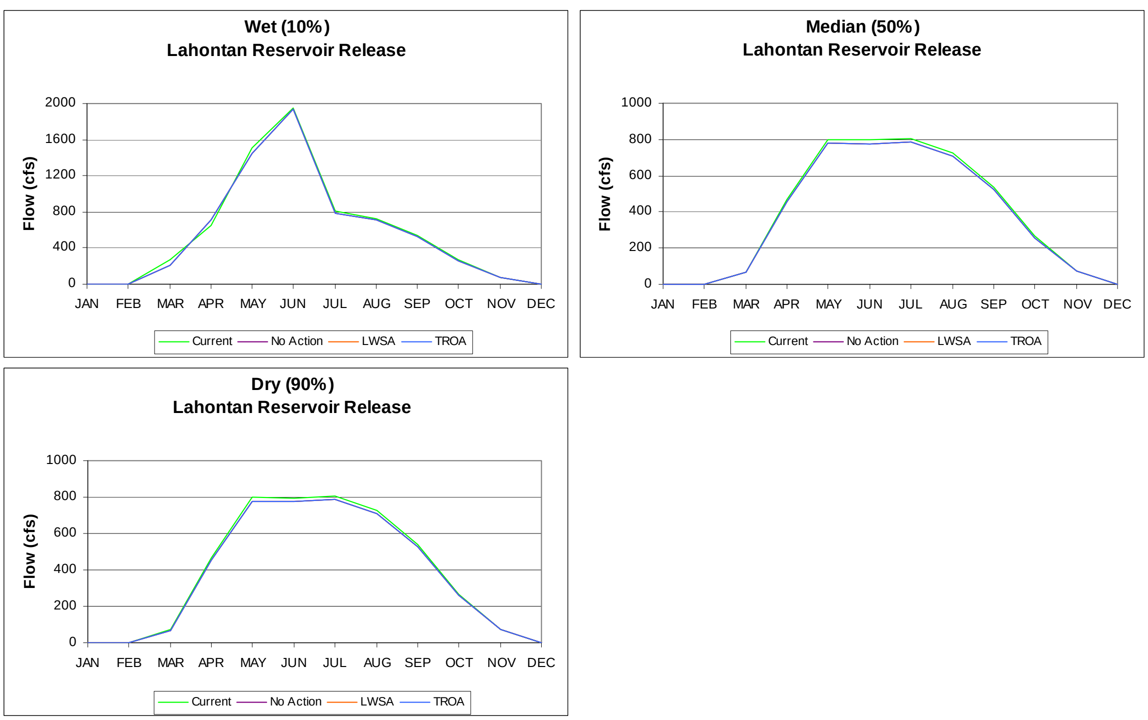


Figure 3.16—Operations model results for Lahontan Reservoir average monthly releases.

b. No Action

(1) Total Reservoir Storage

Operations model results show that total end-of-month reservoir storage under No Action is slightly (less than 1 percent) less than under current conditions. See figure 3.3. The difference is attributable to greater demands in the future for M&I water in the Lake Tahoe and Truckee River basins.

(2) Lake Tahoe

Operations model results show that, under No Action, Lake Tahoe storage is about 5,000 acre-feet less than under current conditions (less than 1 percent of total reservoir storage capacity), which is attributable to greater future demand for M&I water in the Lake Tahoe basin. See figure 3.4.

Lake Tahoe releases under No Action are slightly (2 percent) greater in median hydrologic conditions than under current conditions because of slightly greater releases from Lake Tahoe to meet Floriston Rates from September through March. The greatest releases (about 1,500 cfs) occur in February and March in wet hydrologic conditions when a large portion of the snowpack melts rapidly. Releases from Lake Tahoe under No Action are slightly less (2 to 14 cfs, or 1 to 2.5 percent) in wet and dry hydrologic conditions than under current conditions because of greater demand in the Lake Tahoe basin. In dry hydrologic conditions, minimum releases are only available to be made from May through July. As under current conditions, when Lake Tahoe elevation falls below its natural rim, no releases can be made. See figure 3.5.

(3) Donner Lake

Donner Lake storage and releases are similar under No Action and current conditions. See figures 3.6 and 3.7.

(4) Prosser Creek Reservoir

Operations model results show that Prosser Creek Reservoir storage generally is the same under No Action and current conditions from October through July in wet and median hydrologic conditions. In August and September, storage in median hydrologic conditions under No Action is about 3,000 acre-feet greater than under current conditions. In dry hydrologic conditions, storage is double that under current conditions, which reflects greater Newlands Project demand under current conditions. See figure 3.8.

Release patterns are similar under No Action and current conditions, except May through July releases are less and October releases in median to dry hydrologic conditions are greater. See figure 3.9. Releases are less because Newlands Project demand is less; greater October releases reflect greater storage in September and the requirement to lower reservoir storage to meet dam safety requirements in mid-November.

(5) Independence Lake

Operations model results show similar Independence Lake storage and releases under No Action and current conditions. See figures 3.10 and 3.11.

(6) Stampede Reservoir

In wet hydrologic conditions, under No Action, Stampede Reservoir storage in August and September is slightly greater than under current conditions; storage in median and dry hydrologic conditions is similar to that under current conditions. See figure 3.12. Stampede Reservoir releases shift slightly from July through September under No Action. In drier hydrologic conditions, releases are slightly greater than under current conditions; in wet to median hydrologic conditions, releases are slightly less than under current conditions. See figure 3.13. The shift in storage and release patterns results from additional water flowing to Pyramid Lake (Water Quality Water) and from the difference in Newlands Project demand.

(7) Boca Reservoir

Boca Reservoir operations under No Action are the same as under current conditions, and storage and release patterns are very similar. See figure 3.14.

(8) Lahontan Reservoir

Operations model results show that Lahontan Reservoir storage under No Action is about 5,400 acre-feet less (3 percent) than under current conditions.

In wet hydrologic conditions, storage under No Action is about 1 percent greater than under current conditions because less Carson Division demand reduces the draw on storage. In median hydrologic conditions, storage is 4,400 acre-feet less (3 percent) than under current conditions. In dry hydrologic conditions, storage is greater under current conditions than No Action with a maximum difference of 20,000 acre-feet.

Operations model results show that Lahontan Reservoir releases (made from March through November) meet Carson Division demands about 90 percent of the time.

No releases are made, and the reservoir stores inflow, from December through the following February. In general, releases under No Action are about 3 percent less than under current conditions because demand is less.

The differences between No Action and current conditions are a result of (1) reduced diversions from the Truckee River because of reduced future Newlands Project demand; (2) greater demands in the future in the Lake Tahoe and Truckee River basins, reducing the availability of water supplies to downstream water rights holders; and (3) full exercise of Claim Nos. 1 and 2 of the *Orr Ditch* decree.

c. LWSA

(1) Total Reservoir Storage

Operations model results show that total end-of-month reservoir storage is similar under LWSA and No Action in wet, median, and dry hydrologic conditions. When compared to current conditions, the difference is less than 1 percent overall. See figure 3.3.

(2) Lake Tahoe, Donner Lake, Prosser Creek Reservoir, Independence Lake, Stampede Reservoir, and Boca Reservoir

Storage is slightly less under LWSA in all hydrologic conditions than under No Action because of the exercise of TMWA's water rights to provide 1,000 acre-feet in winter months to the increased groundwater recharge program and greater surface water demand in California. The greatest difference in storage at any reservoir is 700 acre-feet less in Stampede Reservoir in median hydrologic conditions. As shown in figures 3.4 through 3.14, operations model results show no difference in storage and release patterns between No Action and LWSA. Differences in storage and releases between LWSA and current conditions are similar to those differences between LWSA and No Action.

(3) Lahontan Reservoir

Operation model results show that Lahontan Reservoir storage under LWSA is the same as under No Action in wet hydrologic conditions, 100 acre-feet less in median hydrologic conditions, and 300 acre-feet less in dry hydrologic conditions. See figure 3.15. These differences are the result of the exercise of TMWA's water rights to provide 1,000 acre-feet in winter months to the increased groundwater recharge program and greater surface water demand in California. Storage under LWSA is 1 percent greater in wet hydrologic conditions, 3 percent less in median hydrologic conditions, and 18 percent less in dry hydrologic conditions than under current conditions.

Releases under LWSA are the same as under No Action in all three hydrologic conditions and 3 percent less than under current conditions (figure 3.16).

d. TROA

Operations model results show that total end-of-month reservoir storage under TROA is greater than under No Action, LWSA, and current conditions. More storage is held primarily in Prosser Creek, Stampede, and Boca Reservoirs as the result of storage of Credit Waters (which includes Joint Program Fish Credit Water).

(1) Total Reservoir Storage

Total end-of-month reservoir storage under TROA is about 1 percent greater in wet hydrologic conditions and 5 percent greater in median hydrologic conditions than under No Action or current conditions. See figure 3.3. In dry hydrologic conditions, the total reservoir storage is much greater: 56 percent greater than under No Action and 53 percent greater than under current conditions. As a result, recreational and environmental objectives would be met frequently.

(2) Lake Tahoe

Operations model results show that, under TROA, Lake Tahoe storage in wet hydrologic conditions is slightly less (1,000 acre-feet) than under No Action or current conditions because Credit Water would be exchanged to another reservoir to protect it from spilling when possible. Approximately 2,000 acre-feet more is stored under TROA in median hydrologic conditions than under No Action because Credit Water is more secure in Lake Tahoe. In dry hydrologic conditions, Lake Tahoe storage under TROA is 9 percent less than under No Action and 15 percent less than under current conditions. See figure 3.4.

Less storage in dry hydrologic conditions results primarily from two provisions under TROA. One provision relates to the exchange of Floriston Rate Water from Lake Tahoe to Stampede Reservoir and the associated increase in release from Lake Tahoe designated to flow to Pyramid Lake. Occasionally, this extra release from Lake Tahoe coincides with a season when Floriston Rates are supplied from Lake Tahoe storage before they are supplied from Boca Reservoir storage. Operations model results show that Lake Tahoe storage drops so low shortly thereafter that the minimum releases cannot be maintained. In such case, the Lake Tahoe release (in exchange for Stampede Reservoir storage) under TROA is greater than the release under No Action. Thus, storage under TROA is less than under No Action.

The other provision relates to when Lake Tahoe is the first reservoir used to supply Floriston Rates: releases are greater under TROA than under No Action because Credit Water is stored in Lake Tahoe. Therefore, releases of Floriston Rate water under TROA are higher than under No Action, and, consequently, less Tahoe Floriston Rate Water is stored. When inflow in a subsequent month is sufficient to reduce Floriston Rate Water demand on Lake Tahoe, Credit Water is released from storage. Then, in subsequent months (as Lake Tahoe drops to its rim elevation), storage and releases are less than under No Action. The result of these two provisions is to allow slightly more Floriston Rate water to be released in dry hydrologic conditions. Both of these provisions are subject to the approval of the Administrator.

Under TROA, Lake Tahoe releases are slightly greater (2 percent) than under No Action and current conditions in wet and median hydrologic conditions. In median hydrologic conditions, greater April through July releases offset less releases the remainder of the year. In dry hydrologic conditions, Lake Tahoe releases under TROA are 2.5 percent less than under No Action and 5 percent less than under current conditions. See figure 3.5.

Operations model results show that October through January releases from Lake Tahoe under TROA are generally less than under No Action and current conditions. The greatest difference occurs in October; the difference is less in each succeeding month. In October, establishment of credit storage in Lake Tahoe under TROA results in less releases, and, during October, Floriston Rate demand is partially supplied by releases from Stampede Reservoir. These October releases from Stampede Reservoir result from previous (calendar year) exchange of Lake Tahoe Floriston Rate storage into Stampede Reservoir.

February through March releases under TROA are about the same as under either No Action or current conditions. Under TROA, flows are maintained at 75 cfs about 10 percent more often than under No Action or current conditions because of the opportunity to make additional releases using Credit Water stored in Lake Tahoe. These additional releases are made when the releases can be matched by an accumulation of storage in another reservoir. Under TROA, releases are less than the 50 cfs minimum slightly more often due to less Lake Tahoe storage.

April through July releases in wet and median hydrologic conditions under TROA are greater than under No Action and current conditions. Operations model results show these greater releases occur most dramatically in median hydrologic conditions, primarily because Credit Water is released to (1) support spawning of cui-ui, (2) provide the 75 cfs enhanced minimum releases, and (3) exchange Floriston Rate Water from Lake Tahoe into Stampede Reservoir. In wet and median hydrologic conditions, preferred flows for enhancing recreational and environmental uses are met. Note that this release of Credit Water from Lake Tahoe and the exchange into Stampede Reservoir reduces releases from Stampede Reservoir.

August through September releases under TROA generally are less than under No Action and current conditions. Releases are less primarily because of (1) less releases associated with establishment of Credit Water storage under TROA and (2) less Lake Tahoe releases of Floriston Rate Water because, under TROA, this is the period when Lake Tahoe Floriston Rate Water exchanged to Stampede Reservoir during the spring months begins to be released from Stampede Reservoir. Under TROA, releases are slightly greater than under No Action 10 to 15 percent of the time because of enhanced minimum releases of 75 cfs compared to the minimum releases of 70 cfs.

(3) Donner Lake

From June through August, Donner Lake storage under TROA is slightly less (0-400 acre-feet) than under No Action or current conditions as a result of greater minimum release requirements under TROA.

In September, storage under TROA is greater in median (1,600 acre-feet more) and dry (800 acre-feet more) hydrologic conditions than under current conditions. Under TROA, August through September releases are patterned after the California Guidelines and are more uniform than under the No Action or current conditions. As a result, under TROA, August releases tend to be greater and September releases tend to be less than under the other alternatives. In other months, storage under TROA is the same as under No Action or current conditions. Average annual storage in wet, median, and dry hydrologic conditions is similar under TROA, No Action, and current conditions. See figure 3.6

October releases under TROA tend to be greater than under No Action or current conditions, primarily because of (1) releases from Donner Lake to establish TMWA M&I Credit Water in other Truckee River reservoirs and (2) California Guidelines preferred releases to meet target flows downstream from Donner Lake are greater.

November through May releases are similar under TROA, No Action, and current conditions. Releases from mid-November through early April are unregulated.

Under TROA, June releases are greater than under No Action or current conditions approximately 35 percent of the time and July releases are greater than under No Action or current conditions approximately 85 percent of the time. This is because of greater flow targets.

August releases under TROA are greater in wet, median, and dry hydrologic conditions than under No Action and current conditions because of greater flow targets under TROA.

September releases in dry hydrologic conditions under TROA are greater than No Action or current conditions. In median to wet hydrologic conditions, releases under TROA are less than under No Action or current conditions because water is released to meet the preferred releases of 10 cfs. See figure 3.7.

(4) Prosser Creek Reservoir

Prosser Creek Reservoir storage under TROA is greater than under No Action or current conditions because TROA includes numerous categories of water storage and considers recreational pool targets. The combination of storing Credit Waters and Project Water to help achieve recreational pool targets provides greater August storage than any other alternative. See figure 3.8.

In wet hydrologic conditions, storage under TROA is essentially the same as under No Action or current conditions.

In median hydrologic conditions, from August through September, storage under TROA is up to 10,000 acre-feet greater (55 percent more) than under No Action and up to 13,000 acre-feet greater than under current conditions. Overall, storage under TROA is 13 percent greater than under No Action and 17 percent greater than under current conditions.

In dry hydrologic conditions, storage under TROA is 60 percent greater than under No Action and 180 percent greater than under current conditions. This dramatically greater storage would provide substantial benefits. Storage of Credit Waters would provide the opportunity to meet demands and to enhance recreation by keeping the reservoir much higher. Operations model results show that the recreational pool target of 19,000 acre-feet is achieved 70 percent of the time.

September through October releases from Prosser Creek Reservoir under TROA are greater than under No Action or current conditions because August storage is greater under TROA, and storage in excess of 9,800 acre-feet must be released by the end of October. In median and dry hydrologic conditions, October releases under TROA are at least 50 percent greater than under No Action or current conditions.

November through April releases are similar under TROA, No Action, and current conditions because of flood control operations.

May through July releases under TROA tend to be much less than under No Action or current conditions because Credit Waters are accumulating, resulting in less releases. In wet, median, and dry hydrologic conditions, releases under TROA are less than under the other alternatives because of operations to meet recreational pool targets.

August releases under TROA generally are greater than under No Action or current conditions. August releases are patterned after the California Guidelines' preferred minimum releases and under TROA are more uniform than under No Action or current conditions. See figure 3.9.

(5) Independence Lake

Independence Lake storage under TROA is similar in wet and median hydrologic conditions and slightly less than under No Action or current conditions primarily because, under TROA, releases are made to satisfy much greater minimum streamflows and for re-storage as TMWA M&I Credit Water in a downstream reservoir. See figure 3.10. Operations model results show that this release for re-storage tends to be greater in August under TROA.

June through September releases in dry hydrologic conditions under TROA are greater than under No Action or current conditions because California Guidelines' preferred releases (to meet target flows downstream from Independence Lake) are greater.

October through January releases are about the same under TROA, No Action, and current conditions. The lowest flows tend to be slightly greater under TROA because of greater minimum flow targets and because more water is withdrawn from Independence Reservoir for re-storage in other reservoirs.

February releases are slightly greater and March releases under TROA are slightly less than under No Action or current conditions because of preferred releases to meet flow targets downstream from Independence Lake.

April through July releases under TROA are about the same as under No Action or current conditions. Under TROA, releases are sometimes greater because of greater streamflow objectives.

Under TROA, August releases are greater in dry and median hydrologic conditions than under No Action or current conditions. For example, releases in August are at least 8 cfs about 80 percent of the time under TROA but only about 40 percent of the time under No Action or current conditions. Under TROA, August through September releases are patterned after the California Guidelines and are more uniform than under the No Action or current conditions. As a result, August releases under TROA tend to be greater and September releases tend to be less than under the other alternatives. See figure 3.11.

(6) Stampede Reservoir

Operations model results show that Stampede Reservoir storage under TROA is generally greater than under No Action or current conditions in wet, median, and dry hydrologic conditions. See figure 3.12. When storage is greater than 210,000 acre-feet, storage is similar under TROA, No Action, and current conditions. When storage is less than 210,000 acre-feet (about 75 percent of the time), storage under TROA is generally 30,000 to 50,000 acre-feet greater than under No Action or current conditions. In dry hydrologic conditions, storage is as much as 87,000 acre-feet under TROA, compared to only 40,000 acre-feet under No Action and 33,000 acre-feet under current conditions. Minimum storage in Stampede Reservoir under TROA is about 9,000 acre-feet, compared to about 4,600 acre-feet under No Action or current conditions.

Stampede Reservoir storage is greater under TROA because of Credit Water and exchange of Lake Tahoe Floriston Rate Water. Release of Lake Tahoe Floriston Rate Water extends from August into October. Under TROA, the annual storage right for Stampede Reservoir is assumed to be 226,500 acre-feet.

Under TROA, October through January releases provide more frequent and more sustained releases at the rate of the enhanced minimum release (45 cfs). In addition, operations model results show that TROA provides greater releases to supply Floriston Rate Water using the Lake Tahoe Floriston Rate Water exchanged into Stampede Reservoir and provides greater release or spill during October to pull the storage down to the flood control pool. Under TROA, operations model results show that reservoir storage must be released or spilled in more years to provide the required flood control space.

February through March releases under TROA generally are less than under No Action or current conditions because Credit Waters are being accumulated at this time except for 10 percent of the time when the enhanced minimum releases provided during dry hydrologic conditions and about 5 percent of the time when releases are greater than under the other alternatives as the result of Credit Water storage causing spills.

April through July releases under TROA differ from those under other alternatives because of the maintenance of 45 cfs enhanced minimum release and use of an exchange with Lake Tahoe Floriston Rate Water, which limits release to about 125 cfs, the preferred release.

Generally, August through September releases under TROA are the same as or greater than under No Action or current conditions because of the following operations:

- Maintain the 45 cfs enhanced minimum release
- Release exchanged Lake Tahoe Floriston Rate Water
- Provide flood control space by the end of October

See figure 3.13.

(7) Boca Reservoir

Most of the time, Boca Reservoir storage under TROA is greater than under No Action or current conditions (figures 3.14). Storage of Credit Water and Project Water, as well as water released from Stampede Reservoir to meet enhanced and preferred minimum releases, can be re-stored in Boca Reservoir. As discussed previously, releases from Boca Reservoir are not necessarily indicative of hydrologic conditions and were not analyzed.

(8) Lahontan Reservoir

Because *Orr Ditch* decree water rights would be more fully exercised by senior water rights holders to create Credit Water, operations model results show that Lahontan Reservoir storage under TROA is slightly less than under No Action. Storage is also less than under current conditions because of fewer Carson Division demands in the future, which reduces the Lahontan Reservoir OCAP storage targets. Carson Division demands are met in wet, median, and dry hydrologic conditions. See figures 3.15 and 3.16.

D. Flows

1. Method of Analysis and Operations Model Input

Model operations and inputs are the same as for "Reservoirs." Monthly average Truckee River flows at Farad and Vista, generated from the operations model, were compared in wet, median, and dry hydrologic conditions for current conditions, No Action, LWSA, and TROA.

2. Model Results and Evaluation of Effects

Average monthly flows in wet, median, and dry hydrologic conditions under current conditions, No Action, LWSA, and TROA at each location are presented in figure 3.17 (Truckee River at Farad, California) and figure 3.18 (Truckee River at Vista, Nevada).

a. Current Conditions

Table 3.17 presents average annual Truckee River flows at Farad and Vista in wet, median, and dry hydrologic conditions.

The Water Resources Appendix, Exhibits 9-11, shows modeled average monthly flows at all locations (in tables), as well as monthly, seasonal, and annual exceedence frequency curves.

(1) Truckee River Flows at Farad

Flows at Farad represent the combined releases from Lake Tahoe, Donner Lake, Martis Creek Reservoir, Prosser Creek Reservoir, and Boca Reservoir added to the uncontrolled runoff of the Truckee River between Lake Tahoe and Farad. This reach indicates the quantity of water available for use in Nevada.

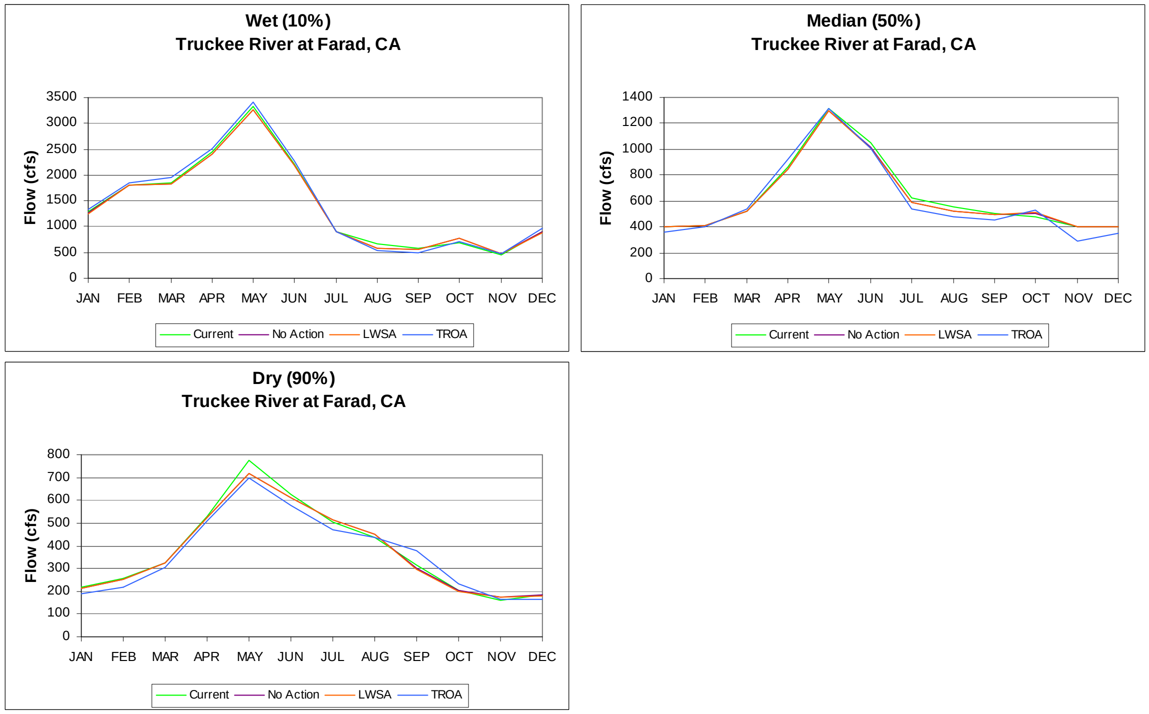


Figure 3.17—Operations model results for average monthly Truckee River flows at Farad.

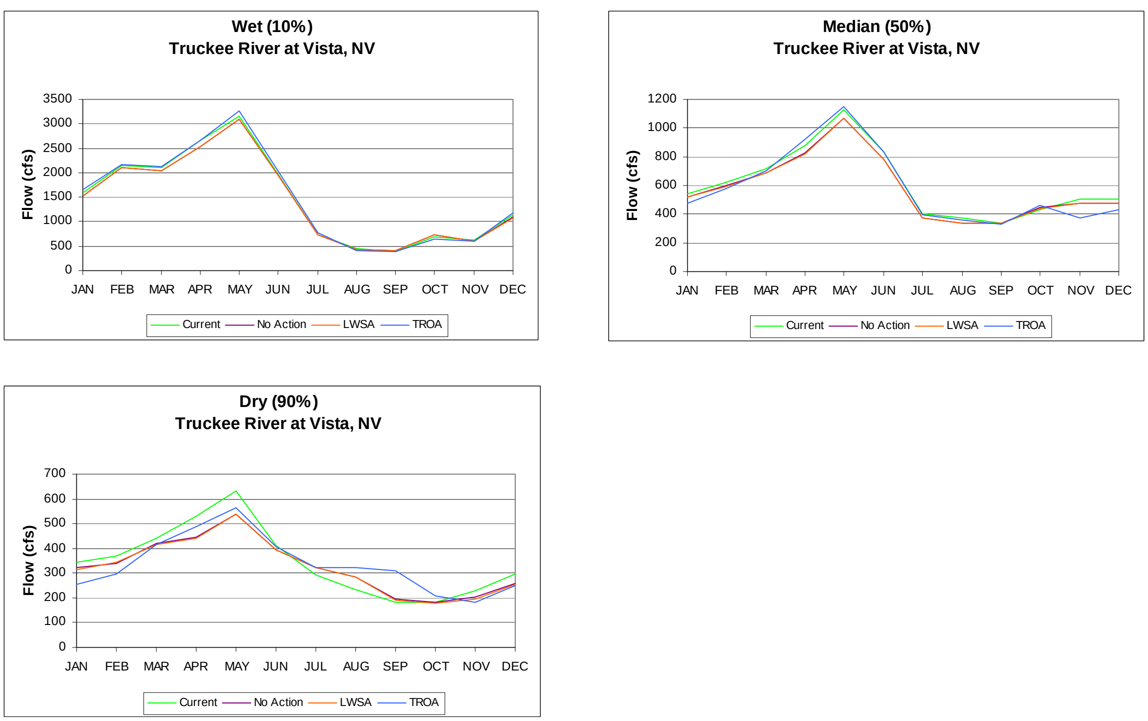


Figure 3.18—Operations model results for average monthly Truckee River flows at Vista.

Table 3.17—Average annual Truckee River flows (cfs) in wet, median, and dry hydrologic conditions at Farad and Vista

Hydrologic condition	Current conditions	No Action	LWSA	TROA
Farad				
Wet	1,427	1,412	1,411	1,450
Median	657	641	641	628
Dry	429	424	423	421
Vista				
Wet	1,458	1,427	1,425	1,480
Median	642	614	612	621
Dry	398	382	381	392

Operations model results show that Floriston Rates are achieved in all months in wet and median hydrologic conditions under current conditions. In dry hydrologic conditions, Floriston Rates are not achieved from August through February. In these months, flow represents the natural runoff (i.e., the amount of water which would have been available if there were no reservoirs) because the reservoirs have little or no stored water available for release. Maximum flow is 3,323 cfs in May in wet hydrologic conditions; minimum flow is 162 cfs in November in dry hydrologic conditions. See figure 3.17.

(2) Truckee River Flows at Vista

Flows at Vista indicate the water supply available to the Truckee Canal or Pyramid Lake. Flows at Vista are very similar to flows at Farad (figure 3.18). In wet hydrologic conditions, flows at Vista are generally greater than at Farad because of the addition of natural runoff downstream from Farad. In median and dry hydrologic conditions, flows are less than at Farad from May through October because of the exercise of agricultural and M&I water rights. Flows are greater than at Farad from November through the following April. Average annual flows at Vista are the same as at Farad. Vista flows are 93 percent of Farad flows in dry hydrologic conditions, but average 102 percent and 97 percent of these flows in wet and median hydrologic conditions, respectively. Maximum flows in wet hydrologic conditions are 3,158 cfs in May; minimum monthly flows in dry hydrologic conditions are 181 cfs in September.

b. No Action

Comparison of average seasonal flows at various locations in the Truckee River basin indicates the availability of water to meet flow targets and support environmental and recreational uses. As shown in table 3.16, in general, flows under No Action are less under than under current conditions because of greater future demands in California and Nevada.

(1) Truckee River Flows at Farad

Operations model results show that Floriston Rates are achieved in all months in wet and median hydrologic conditions under No Action. In dry hydrologic conditions, Floriston Rates are not achieved from August through the following February because Lake Tahoe is at or near its natural rim***;*** thus little to no stored water is available to be released for Floriston Rates. See figure 3.17.

Maximum flows are 3,269 cfs in May in wet hydrologic conditions, and minimum flows are 175 cfs in November in dry hydrologic conditions. Average annual flows are about 99 percent of those under current conditions. Average annual flows are slightly less because of increased demand in the Lake Tahoe basin and Truckee River basin in California. In general, flows at Farad are slightly less than under current conditions, except in drier hydrologic conditions from June through September, when Water Quality Credit Water is available for release.

(2) Truckee River Flows at Vista

Operations model results show that in dry hydrologic conditions, under No Action, July through August flows at Vista are somewhat greater (more than 13 cfs) than under current because of the release of Water Quality Credit Water to improve water quality in the river from Truckee Meadows to Pyramid Lake. See figure 3.18.

Maximum flows are 3,092 cfs in May in wet hydrologic conditions, and minimum flows are 181 cfs in October in dry hydrologic conditions. Average annual flows are about 98 percent of those under current conditions. Flows from Farad to Vista flows are slightly less because of greater future demand in Truckee Meadows.

c. LWSA

Operations model results show that Truckee River flows at Farad and Vista in wet, median, and dry hydrologic conditions under LWSA are about the same as under No Action. See figures 3.17 and 3.18.

d. TROA

(1) Truckee River Flows at Farad

Flows at Farad under TROA are 3 percent greater in wet hydrologic conditions and 2 percent less in median and dry hydrologic conditions than under No Action; flows are 2 percent greater in wet hydrologic conditions and 2 percent less in median and dry hydrologic conditions than under current conditions. Flows are greater under TROA in wet hydrologic conditions because of greater spills from February through June, and flows are less in median and dry hydrologic conditions because of storage of Credit Water from October through March. Average annual flows at Farad under TROA are 99 percent of those under No Action and 98 percent of those under current conditions. See figure 3.17.

Maximum flows are 3,409 cfs in May in wet hydrologic conditions, or 4 percent greater than under No Action and 3 percent greater than under current conditions. Minimum flows are 165 cfs in November in dry hydrologic conditions.

(2) Truckee River Flows at Vista

Generally, under TROA, Truckee River flows at Vista under TROA are 2 percent greater than under No Action and 1 percent less than under current conditions. See figure 3.19. Maximum flows are 3,270 cfs in wet hydrologic conditions, or 7 percent greater than under No Action and 4 percent greater than under current conditions. Minimum flows under TROA in dry hydrologic conditions are 1 percent greater than under No Action or current conditions.

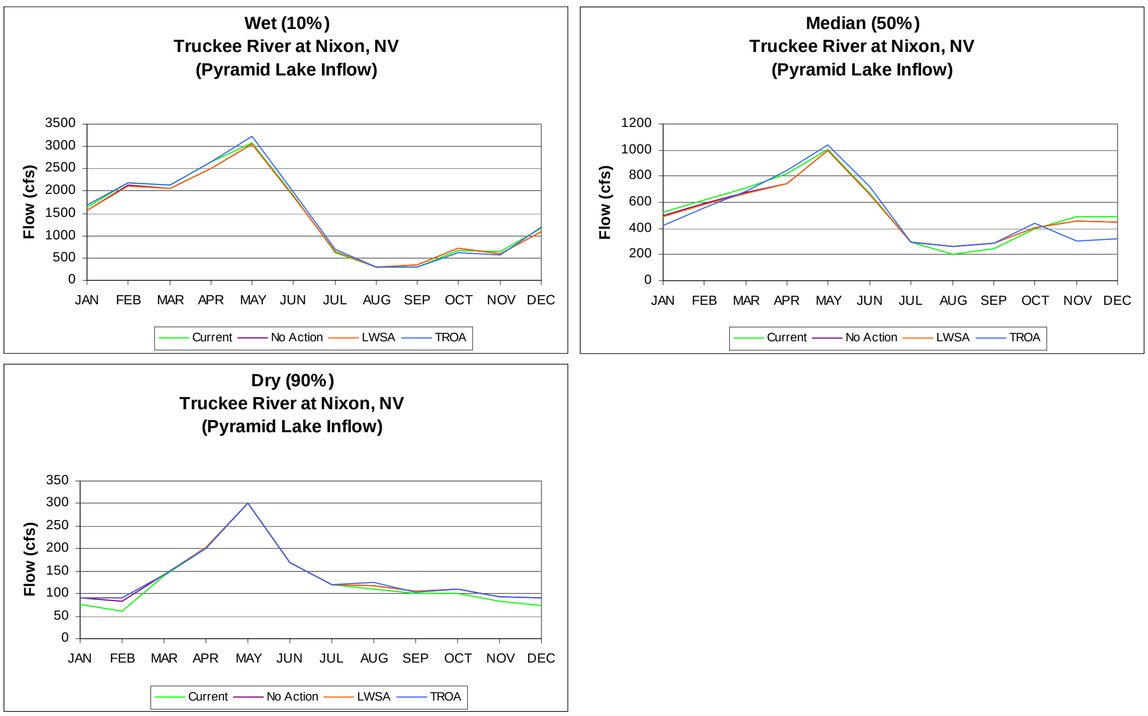


Figure 3.19—Operations model results for Truckee River flows at Nixon.

October through January flows generally under TROA are slightly less than under No Action or current conditions, primarily because of the accumulation of Credit Waters.

February through March flows under TROA, No Action, and current conditions follow the same pattern as October through January flows; flows generally are less under TROA in median and dry hydrologic conditions because of the accumulation of Credit Waters. In wet hydrologic conditions, flows are greater under TROA because more Credit Water is in storage, which causes more frequent spills.

In wet hydrologic conditions, April through July flows under TROA are greater than under No Action or current conditions because more Credit Water is in storage, which causes more frequent spills. In median and dry hydrologic conditions, flows under TROA are about the same as under No Action. Flows under TROA are generally less than under current conditions in median hydrologic conditions.

About 50 percent of the time, August through September flows under TROA are slightly less than under No Action or current conditions in higher flow situations. Under No Action and current conditions, there is very little opportunity for storing this surplus water during these months. Thus, under No Action, the surplus water remains in the Truckee River and flows into Pyramid Lake. Under TROA, such surplus water frequently can be stored in Truckee River reservoirs.

E. Pyramid Lake

1. Method of Analysis and Operations Model Input

Model operations and inputs are the same as for "Reservoirs." Pyramid Lake monthly average inflow (evaluated at Nixon), generated from the operations model, was compared in wet, median, and dry hydrologic conditions for current conditions, No Action, LWSA, and TROA. Simulated Pyramid Lake elevations also were compared.

2. Model Results and Evaluation of Effects

Monthly average Pyramid Lake inflow in wet, median, and dry hydrologic conditions for current conditions and the alternatives are presented in figure 3.19. The difference between current conditions and the alternatives in operations model results for the elevation of Pyramid Lake at the end of the period of analysis is presented in figure 3.20.

a. Current Conditions

Table 3.18 presents Pyramid Lake average annual inflow in wet, median, and dry hydrologic conditions.

Table 3.18—Pyramid Lake average annual inflow at Nixon (cfs) in wet, median, and dry hydrologic conditions

Hydrologic condition	Current	No Action	LWSA	TROA
Wet	1,412	1,396	1,394	1,452
Median	580	563	561	566
Dry	146	151	151	162

The Water Resources Appendix, Exhibits 9-11, shows modeled average monthly flow at Nixon, as well as monthly, seasonal, and annual exceedence frequency curves.

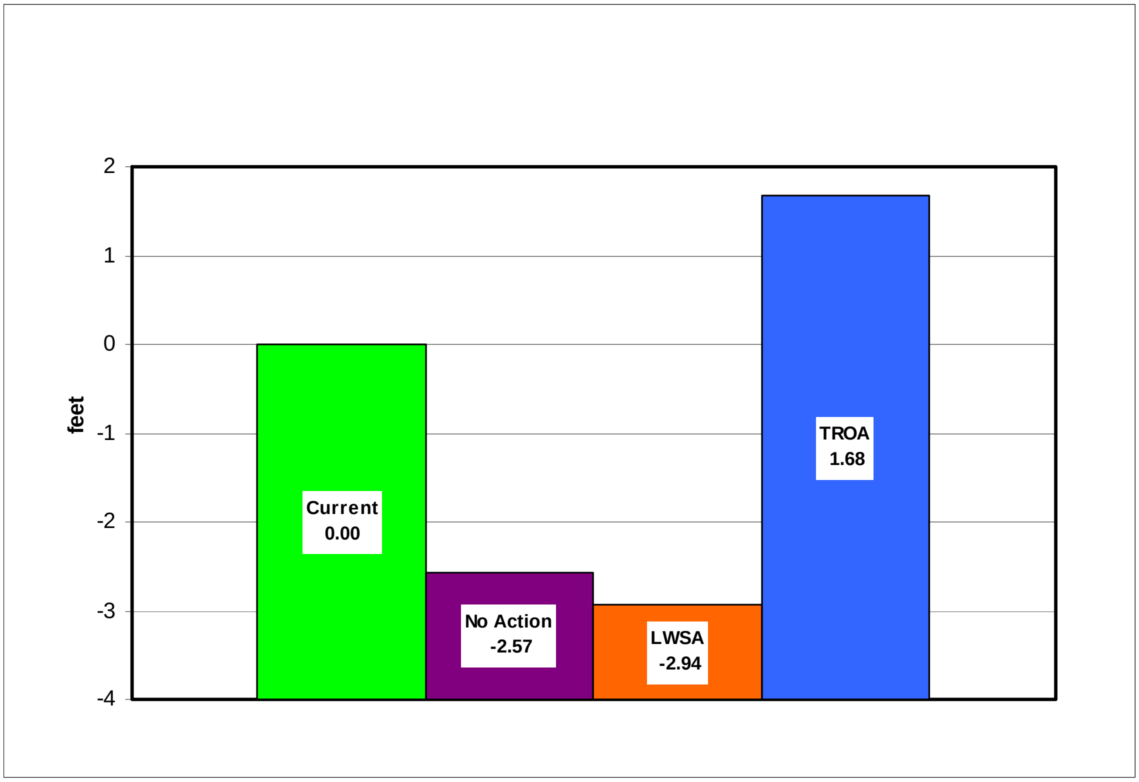


Figure 3.20—Difference between current conditions and alternatives in operations model results for the elevation of Pyramid Lake at the end of the period of analysis.

(1) Pyramid Lake Inflow (Truckee River Flows at Nixon)

Truckee River flow at Nixon represents inflow to Pyramid Lake. Operations model results show that the flow pattern at Nixon is similar to that at Vista, but quantity is reduced by diversions to the Truckee Canal and agricultural uses in the lower Truckee River during the irrigation season from April through September (figure 3.19). Flows at Nixon are 37 percent of flows at Vista in dry hydrologic conditions, but average 97 percent and 91 percent of flows at Vista in wet and median hydrologic conditions, respectively.

In general, flows increase from November through the following May. Increases from October through February result primarily from precipitation and runoff. Increases from March through May are caused by a combination of uncontrolled spring runoff and Stampede Reservoir releases for Pyramid Lake fishes. Flows decrease from June through September as the result of a decrease in natural flows and, to some extent, reservoir releases. The Pyramid Lake inflow target decreases in these months under the six-flow regime operation, so releases from Stampede and Prosser Creek Reservoirs are reduced. Maximum flows are 3,089 cfs in May in wet hydrologic conditions; minimum flows are 62 cfs in February in dry hydrologic conditions.

See “Biological Resources” for analysis and discussion of the six-flow regime effect on Pyramid Lake inflow.

(2) Pyramid Lake Elevation

Under current conditions, operations model results show that the simulated elevation of Pyramid Lake is 49 feet higher by the end of the 100-year period of analysis. Figure 3.20 presents operations model results for current conditions and the alternatives.

b. No Action

Comparison of average seasonal flows at various locations in the Truckee River basin indicates the availability of water to meet flow targets and support environmental and recreational uses. As shown in table 3.18, in general, flows under No Action are less than under current conditions because of greater future demands in California and Nevada.

(1) Pyramid Lake Inflow (Truckee River Flows at Nixon)

Operations model results show that, under No Action, June through September Truckee River flows at Nixon are somewhat greater than under current conditions in dry hydrologic conditions because of Water Quality Water releases. See figure 3.19. Maximum flows are 3,055 cfs in May in wet hydrologic conditions. Minimum flows are 83 cfs in February in dry hydrologic conditions. Average annual flows are about 98 percent of those under current conditions.

See “Biological Resources” for analysis and discussion of the six-flow regime effects on Pyramid Lake inflow.

(2) Pyramid Lake Elevation

Operations model results indicate that, under No Action, the elevation of Pyramid Lake at the end of the period of analysis is about 2.5 feet lower than under current conditions because of greater future demands in California and Nevada. See figure 3.20.

c. LWSA

Operations model results indicate that, under LWSA, the elevation of Pyramid Lake at the end of the period of analysis is about 3 feet lower than under current conditions because of greater future demands in California and Nevada. See figure 3.20.

d. TROA

(1) Pyramid Lake Inflow (Truckee River Flows at Nixon)

Average annual inflow to Pyramid Lake (Truckee River flows at Nixon) under TROA is 2 percent and 1 percent greater than under No Action and current conditions, respectively. In wet hydrologic conditions, flows under TROA are 4 percent greater than under No Action and 3 percent greater than under current conditions. In median hydrologic conditions, flows under TROA are generally 1 percent greater than under No Action and 2 percent less than under current conditions. Maximum flows are 3,231 cfs in May in wet hydrologic conditions, and minimum flows are 90 cfs in February in dry hydrologic conditions. See figure 3.19.

October through January flow patterns at Nixon are similar to those at Vista. Under median and dry hydrologic conditions, flows under TROA are generally less than or equal to flows under No Action or current conditions. The maximum inflow target from October through January is 160 cfs. See table 3.8.

When Pyramid Lake inflow is between 160 cfs and 700 cfs, inflow under TROA is likely to be less than under the other alternatives because of opportunities to store Credit Water. Under TROA, February through March flows are slightly greater in low-flow conditions than under No Action or current conditions because of greater supply. Flows are slightly less under TROA in median hydrologic conditions because of the opportunity to store surplus Truckee River flow.

April-through-July flows are nearly the same under all alternatives. Inflow tends to be slightly greater during extreme low flows under TROA because more water is available from reservoir storage. Also, inflow tends to be greater under TROA in high-flow periods because of greater reservoir spills.

August through September flows under TROA are generally similar or greater than under either No Action or current conditions because more water is available from storage under TROA.

(2) Pyramid Lake Elevation

Operations model results indicate that, under TROA, the elevation of Pyramid Lake at the end of the period of analysis is higher than under No Action or current conditions because of greater average annual inflow of approximately 11,000 and 4,000 acre-feet, respectively. As shown in figure 3.20, operations model results indicate that, under TROA, the elevation of Pyramid Lake at the end of the period of analysis is 4.25 feet higher than under No Action and 1.68 feet higher than under current conditions.

F. Exercise of Water Rights to Meet Demands

1. Method of Analysis

Currently, the Truckee River water supply available for diversion does not satisfy all water rights demands in every year. Variable water rights acquisition and transfers in the future do not allow a direct comparison of the effectiveness of future operations in satisfying the exercise of water rights. Therefore, operations model results were analyzed to determine the percentage of water righted demand that was met in the “minimum supply year.” As part of this analysis, the minimum supply year (or minimum annual water supply) is defined as the calendar year with the least supply to serve water rights over the 100-year period of analysis. Agricultural demands were analyzed for Truckee Meadows, Truckee and Carson Divisions of the Newlands Project, and the lower Truckee River basin; M&I demands were analyzed for the Lake Tahoe basin, Truckee River basin in California and Nevada, and Truckee Meadows. Additionally, Section 205(a) of P.L. 101-618 requires that TROA must carry out the terms, conditions, and contingencies of PSA, one of the purposes of which is to provide additional M&I water for the Reno-Sparks metropolitan area (i.e., Truckee Meadows) during drought; an analysis is included to illustrate the extent to which each condition and alternative contributes to the Truckee Meadows M&I water supply during two drought periods, modeled calendar years 31-35 and 90-94 (that relate to recent historic droughts).

2. Model Results and Evaluation of Effects

Supplies and demands in California are discussed in the narrative. Table 3.19 presents operations model results for Nevada agricultural and M&I minimum annual water supply available and the percentage of water rights demands met by the exercise of water rights in the minimum supply year. Table 3.20 presents operations model results for total M&I water supply available for Truckee Meadows during the modeled calendar years 31-35 and 90-94.

a. Current Conditions

Operations model results show that, under current conditions, water rights cannot be fully served to meet both current agricultural and M&I demands in all years. Agricultural and M&I demands in the Truckee River basin in Nevada are met primarily from surface water sources, subject to the variability of supply.

(1) Agriculture

Truckee Meadows and Newlands Project agricultural demands are served by surface water supplies; supplies are not adequate to fully serve these rights in drought years.

Annual agriculture shortages for Truckee Meadows, the Truckee Division, and the Carson Division are shown in figures 3.21, 3.22, and 3.23. Shortages for the Truckee Division are shown only for current conditions (figure 3.22) because it is assumed that, in the future, all Truckee Division water rights would be acquired for Fernley M&I and water quality improvement purposes.

(a) Truckee Meadows

As shown in table 3.19, operations model results show that in the minimum supply year, 21.4 percent of demand is met in Truckee Meadows. Shortages occur in 14 of the 100 years of analysis.

(b) Truckee Division

Operations model results show that 51.5 percent of demand is met in the Truckee Division. Shortages occur in 9 years of the 100 years of analysis.

(c) Carson Division

Operation model results show that 47.2 percent of demand is met in the Carson Division. Shortages occur in 9 years of the 100 years of analysis.

Table 3.19—Annual demand in Nevada and annual average and minimum agricultural and M&I supplies (acre-feet per year, except where noted)

	Current conditions	No Action	LWSA	TROA
Truckee Meadows				
Agriculture				
Water rights demand	40,770	21,500	21,500	4,860
Average supply	39,170	20,720	20,720	4,690
Minimum supply	8,710	6,510	6,520	1,640
Demand met in minimum supply year	21.4%	30.3%	30.3%	33.7%
M&I				
Water rights demand	83,140	119,000	119,000	119,000
Average supply	83,140	118,410	118,670	118,260
Minimum supply	83,140	108,420	112,690	113,720
Demand met in minimum supply year	100%	91.1%	94.7%	95.6%
Newlands Project – Truckee Division				
Agriculture				
Water rights demand	18,520	0	0	0
Average supply	18,070	N/A	N/A	N/A
Minimum supply	9,530	0	0	0
Demand met in minimum supply year	51.5%	N/A	N/A	N/A
Fernley M&I				
Water rights demand	[1]0	[2]6,800	[2]6,800	[2]6,800
Average supply	0	6,600	6,600	6,600
Minimum supply	0	3,600	3,600	3,600
Demand met in minimum supply year	0	52.9%	52.9%	52.9%
Newlands Project – Carson Division				
Agriculture				
Water rights demand	275,720	268,870	268,870	268,870
Average supply	269,410	260,720	260,610	260,690
Minimum supply	130,070	110,580	109,760	110,790
Demand met in minimum supply year	47.2%	41.1%	40.8%	41.2%
Lower Truckee River (including Pyramid Tribe)				
Agriculture				
Water rights demand	12,040	17,900	17,900	17,900
Average supply	12,040	17,900	17,900	17,900
Minimum supply	12,040	17,900	17,900	17,900
Demand met in minimum supply year	100%	100%	100%	100%
M&I				
Water rights demand	0	16,380	16,380	16,380
Average supply	0	16,380	16,380	16,380
Minimum supply	0	16,380	16,380	16,380
Demand met in minimum supply year	N/A	100%	100%	100%

[1] Current demand of 3,280 acre-feet supplied by local groundwater sources.
[2] Transfer of 6,800 acre-feet of Truckee Division agricultural water rights would provide a portion of the future demand of 29,500 acre-feet; supply for the additional 22,700 acre-feet has not been identified and was not modeled.

Table 3.20—Total M&I water supply available (acre-feet) to the Truckee Meadows service area (current year water deliveries plus end-of-November Stampede Reservoir storage) for the two drought periods (calendar years 31–35 and 90–94) under current conditions and the alternatives (normal year demand in parentheses); supplies less than normal year demand are shown in bold, and greatest supply for the calendar year is shown in *bold italics*

Calendar year	Current conditions[1] (83,100)	No Action[2] (119,000)	LWSA[3] (119,000)	TROA[4] (119,000)
31	97,700	121,800	125,600	***152,300***
32	104,300	141,300	140,800	***168,700***
33	103,700	136,500	137,900	***166,900***
34	96,100	120,100	124,100	***149,900***
35	105,000	137,000	136,800	***164,300***
90	103,100	135,700	137,900	***171,100***
91	100,700	130,900	132,600	***152,400***
92	85,700	**109,600**	**113,800**	***124,500***
93	102,800	138,700	138,300	***144,600***
94	91,200	**107,200**	121,500	***126,800***

[1] Maximum annual groundwater pumping for normal and dry year is 14,820 and 22,000 acre-feet, respectively.
[2] Maximum annual groundwater pumping for normal and dry year is 12,570 and 22,000 acre-feet, respectively.
[3] Maximum annual groundwater pumping for normal and dry year is 12,570 and 26,500 acre-feet, respectively.
[4] Maximum annual groundwater pumping for normal and dry year is 12,570 and 15,950 acre-feet, respectively.

(d) Lower Truckee River Basin

Agricultural demand in the lower Truckee River basin is met 100 percent of the time under current conditions because the Pyramid Tribe holds water rights with the highest priority date.

(2) M&I

(a) Lake Tahoe Basin

M&I demands in the Lake Tahoe basin in California and Nevada are met by surface water and groundwater in all years.

(b) Truckee River Basin in California

M&I demand in the Truckee River basin in California is met primarily by groundwater and is assumed to be met in all years.

(c) Truckee Meadows

Current Truckee Meadows M&I supply is reliable because of TMWA’s ability to supplement the surface water supply with groundwater supplies and Private Water stored in Donner and Independence Lakes. Under current conditions, supplies are adequate to meet demand, in part because of TMWA’s water rights acquisition program. TMWA has acquired more water rights than it currently requires to meet demand. No shortages occur under current conditions, even during the two recent historical droughts as shown in table 3.20.

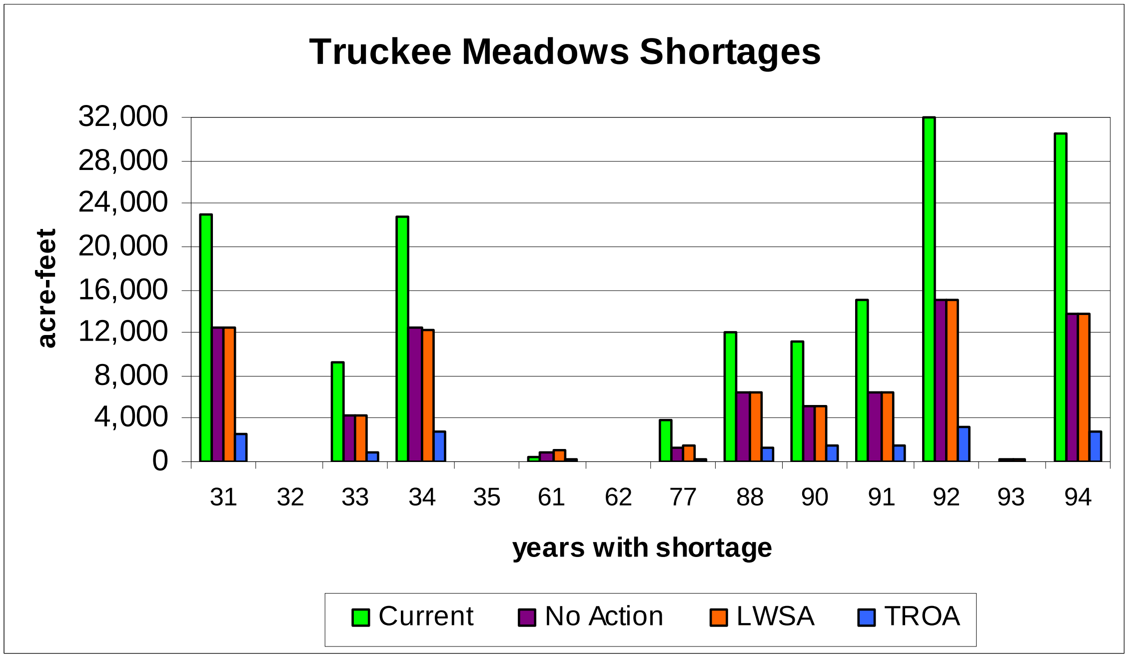


Figure 3.21—Operations model results for Truckee Meadows agricultural shortages.

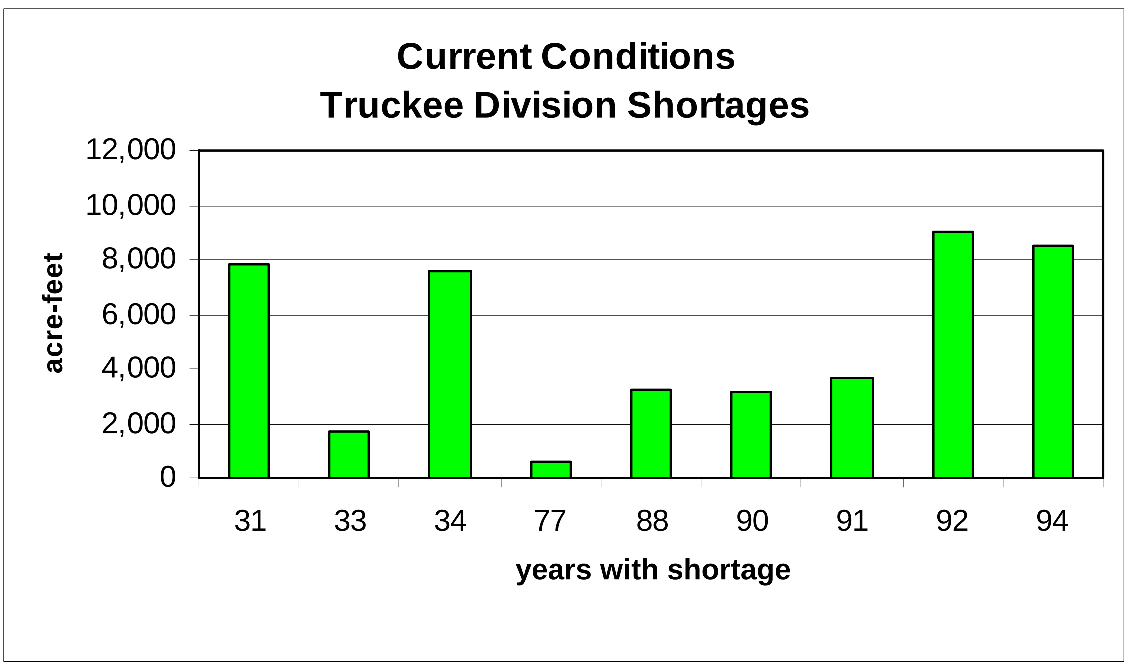


Figure 3.22—Operations model results for current conditions Truckee Division agricultural shortages. (It is assumed that, in the future, all Truckee Division water rights would be acquired for Fernley M&I and water quality improvement purposes.)

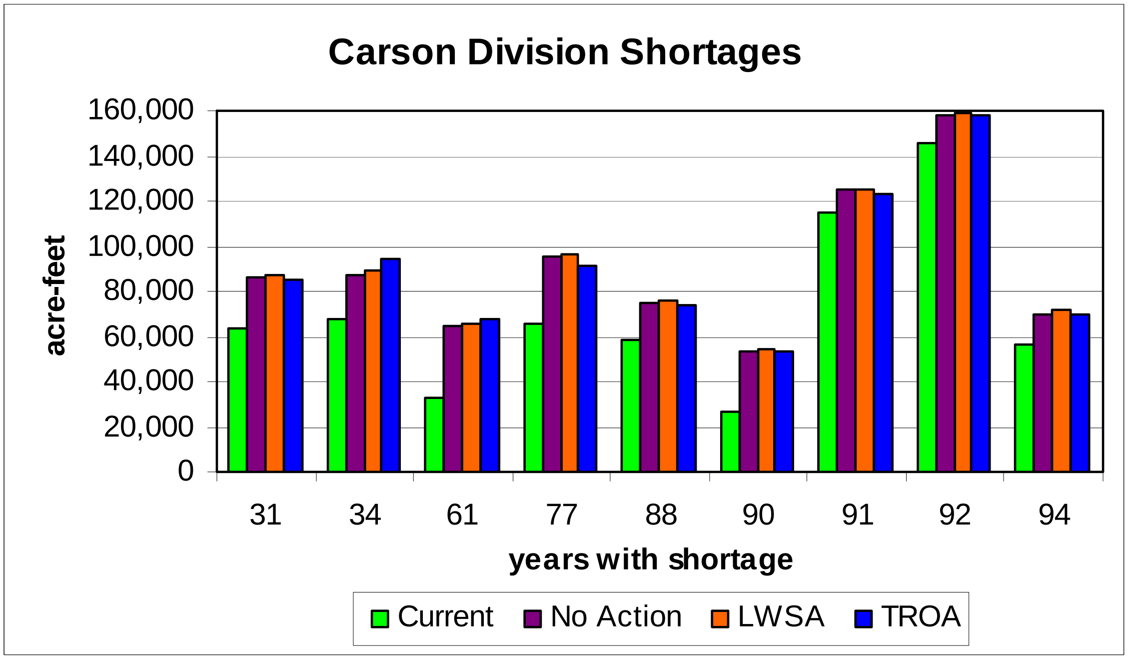


Figure 3.23—Operations model results for Carson Division agricultural shortages.

(d) Lower Truckee River Basin

M&I demand in the lower Truckee River basin is met 100 percent of the time under current conditions because the Pyramid Tribe holds water rights with the highest priority date.

b. No Action

(1) Agriculture

(a) Truckee Meadows

As shown in table 3.19, operations model results show that in the minimum supply year, 30.3 percent of the agricultural demand in Truckee Meadows is met under No Action, compared to 21.4 percent under current conditions because fewer water rights would be required to be served under No Action. Shortages occur in 10 of the 100 years of analysis under current conditions. Under No Action, shortages occur in 14 years of the analysis.

(b) Truckee Division

It is assumed that, in the future, all Truckee Division water rights would be acquired for Fernley M&I and water quality improvement purposes.

(c) Carson Division

Operations model results show that in the minimum supply year, 41.1 percent of the agricultural demand in the Carson Division is met under No Action, or 6.2 percent less than under current conditions, primarily because of future development in California, increased demands in Truckee Meadows, and full exercise of the Pyramid Tribe's Truckee River water rights. Shortages occur in 9 of the 100 years of analysis, and are generally greater than under current conditions. See figure 3.23.

Newlands Project supplies from the Truckee River under No Action are less than under current conditions for the following reasons:

- Carson Division demand is less as a result of WRAP
- California and Nevada water use in the Lake Tahoe basin is greater, thus less water is available to Truckee River users
- California water use from the Truckee River basin is greater, thus less water is available to Nevada
- Use of *Orr Ditch* decree water rights (including Claim Nos. 1 and 2) is greater, thus the proportionate supply to lower priority water rights is less
- Use of reservoir storage in Independence and Donner Lakes is greater, thus less water is available for direct diversion from the Truckee River

(d) Lower Truckee River basin

Agricultural demand in the lower Truckee River basin is met 100 percent of the time under both current conditions and No Action because the Pyramid Tribe holds water rights with the highest priority date.

(2) M&I

(a) Lake Tahoe Basin

The surface water supply is sufficient to satisfy the M&I demand in the Lake Tahoe basin in California and Nevada under current conditions as well as under No Action.

(b) Truckee River Basin in California

The surface water supply is sufficient to satisfy the M&I demand in the Truckee River basin in California under current conditions. Under No Action, the surface water supply is sufficient to meet M&I demand because California has a high priority to divert water from surface flows for M&I purposes.

(c) Truckee Meadows

As discussed previously, Truckee Meadows M&I water demand is projected to be greater in the future. The M&I surface water supply under No Action also would be greater than under current conditions because agricultural water rights would be acquired and transferred to M&I use, and TMWA would more fully exercise its existing water rights. Under No Action, the water supply is not sufficient in all years to meet the greater M&I demand. Operations model results show that, in the minimum supply year, 91.1 percent of the 119,000-acre-foot demand is met under No Action (table 3.19).

Conservation measures would be implemented to reduce demand in water-short years. As shown in table 3.20, the M&I water supply is sufficient to meet demand during the calendar year 31–35 drought but falls short in two of the years during the calendar year 90–94 drought.

(d) Lower Truckee River Basin

M&I demand in the lower Truckee River basin is met 100 percent of the time under both current conditions and No Action because the Pyramid Tribe holds water rights with the highest priority date.

c. LWSA

(1) Agriculture

(a) Truckee Meadows

Operations model results show that agricultural demands in Truckee Meadows under LWSA are met to the same degree as under No Action. The differences between LWSA and current conditions are the same as the differences between No Action and current conditions.

(b) Truckee Division

It is assumed that, in the future, all Truckee Division water rights would be acquired for Fernley M&I and water quality improvement purposes.

(c) Carson Division

As shown in table 3.19, operations model results show that in the minimum supply year, 40.8 percent of the Carson Division demand is met under LWSA, or about .3 percent less than under No Action and 6.4 percent less than under current conditions. Differences are caused by greater exercise of TMWA water rights for the increased groundwater recharge program. Shortages occur in 9 of the 100 years of analysis, the same as under No Action, and are generally greater than under current conditions. See figure 3.23.

(d) Lower Truckee River Basin

M&I demand in the lower Truckee River basin is met 100 percent of the time under both current conditions, No Action, and LWSA because the Pyramid Tribe holds water rights with the highest priority date.

(2) M&I

(a) Lake Tahoe and Truckee River Basins in California

Under LWSA, the M&I water supply for the Lake Tahoe and Truckee River basins is the same as under No Action. Differences between LWSA and current conditions are the same as between No Action and current conditions. Under LWSA, a greater amount of surface water is diverted, but this greater diversion is offset by decreased groundwater use for no net change in California demands.

(b) Truckee Meadows

Truckee Meadows M&I demand under LWSA is the same as under No Action, except TMWA would exercise its water rights to provide an additional 1,000 acre-feet in winter months for an increased groundwater recharge program. Under LWSA, the average water supply is slightly greater than under No Action because of greater groundwater pumping. Operations model results show that, in the minimum supply year, 94.7 percent of the 119,000-acre-foot demand is met, compared to 91.1 percent under No Action (table 3.19). Conservation measures would be implemented but perhaps to a lesser degree than under No Action. As shown in table 3.20, the M&I water supply during the drought periods is similar to that under No Action and sufficient to meet demand during the calendar year 31–35 drought but falls short in only one of the years during the calendar year 90–94 drought; groundwater pumping, however, is likely to be greater than under No Action.

(c) Lower Truckee River Basin

M&I demand in the lower Truckee River basin is met 100 percent of the time under LWSA, No Action, and current conditions because the Pyramid Tribe holds water rights with the highest priority date.

d. TROA

(1) Agriculture

(a) Truckee Meadows

As shown in table 3.19, operations model results show that 33.7 percent of the agricultural demand in Truckee Meadows is met in the minimum supply year under TROA, compared to 30.3 percent under No Action and 21.4 percent under current conditions. As previously discussed, demand under TROA is much less than under current conditions because of TMWA's water rights acquisition program. Shortages occur in 13 of the 100 years of analysis. See figure 3.21.

(b) Truckee Division

It is assumed that, in the future, all Truckee Division water rights would be acquired for Fernley M&I and water quality improvement purposes.

(c) Carson Division

During the most severe drought, agricultural demand in the Carson Division is met to a similar degree under TROA and No Action. The water supply under TROA is slightly less (30 acre-feet) than under No Action. Timing of Truckee River supplies results in a minimal decrease in diversions to the Newlands Project in some years. A total of 41.2 percent of the demand is met in the minimum supply year, compared to 41.1 percent under No Action (about 200 acre-feet more) and 47.2 percent under current conditions. Shortages occur in 9 of the 100 years of analysis, the same as under No Action, and are generally greater than under current conditions. See figure 3.23.

(d) Lower Truckee River Basin
As under No Action and current conditions, agricultural demand in the lower Truckee River basin is met 100 percent of the time under TROA because the Pyramid Tribe's most senior water priority ensures that its agricultural water demand is satisfied.

(2) M&I

(a) Lake Tahoe Basin
Sufficient water supplies are available under TROA, No Action, and current conditions to meet M&I demand in the Lake Tahoe basin in California and Nevada.

(b) Truckee River Basin in California
The surface water supply is sufficient to meet current and future California M&I demand for surface water in the Truckee River basin.

(c) Truckee Meadows
Truckee Meadows M&I demand under TROA is the same as under No Action. The average water supply is slightly less than under No Action because of the requirement for water conservation. Operations model results show that, under TROA, 95.6 percent of the 119,000-acre-foot demand is met in the minimum supply year, compared to 91.1 percent under No Action. The benefits of water conservation and credit storage under TROA are shown clearly in table 3.20: M&I water supply during the drought periods is greater than under No Action (and LWSA) in all years and is sufficient to meet demand during both the calendar year 31–35 and 90–94 droughts; also, groundwater pumping is likely to be less than under No Action (and LWSA). Table 3.20 illustrates that TROA would satisfy the requirement under the Settlement Act to provide additional M&I water for Truckee Meadows during drought situations.

(d) Lower Truckee River Basin
M&I demand in the lower Truckee River basin is met 100 percent of the time under TROA, No Action, and current conditions because the Pyramid Tribe holds water rights with the highest priority date.

G. Optional Scenarios

TROA was modeled using the water demands, credit storage options, and distribution of water rights "most likely" to occur in the future (2033) based on the Negotiated Agreement. Two additional scenarios were analyzed to provide perspective on the effects of potential future Truckee River operations under TROA: (1) Fernley Municipal Credit Water (Fernley scenario) and (2) Donner Storage Right (Donner-TMWA scenario). Under the Fernley scenario, it was assumed that Fernley would store a portion of the water associated with surface water rights acquired from the Truckee Division. Under the Donner-TMWA scenario, it was assumed that TMWA would acquire TCID's portion of the Donner Lake storage right to increase TMWA's M&I water supply.

1. Method of Analysis

The same method of analysis was used for the optional scenarios as for the alternatives. Operations model input assumptions were the same as for TROA, except for the following:

> **Fernley Scenario:** The operations model assumes that of the 6,800 acre-feet of acquired surface water rights, 5,100 acre-feet would be used to meet M&I demand in normal years; the remaining 1,700 acre-feet would be stored as Fernley Municipal Credit Water up to a total of 10,000 acre-feet. Releases would be made to meet Fernley M&I demand when the exercise of Fernley surface water rights could not meet the 5,100 acre-feet of M&I demand.
>
> **Donner-TMWA Scenario**: Donner Lake would be operated to meet TMWA's M&I demand from total reservoir storage.

2. Model Results and Evaluation of Effects

Operations model results for each scenario were compared to operations model results for TROA. Figures 3.24, 3.25, and 3.26 show end-of-month reservoir storage and average monthly releases under the Fernley scenario in wet, median, and dry hydrologic conditions, respectively. Figures 3.27, 3.28, and 3.29 show end-of-month reservoir storage and average monthly releases under the Donner-TMWA scenario in wet, median, and dry hydrologic conditions, respectively.

a. Fernley Scenario

Operations model results show that average total reservoir storage is slightly greater under this scenario because of the storage of Fernley Municipal Credit Water (figures 3.24, 3.25 and 3.26) by the following amounts:

Wet hydrologic conditions	220 acre-feet
Median hydrologic conditions	580 acre-feet
Dry hydrologic conditions	840 acre-feet

In general, operations model results show very little difference between this scenario and TROA in wet and median hydrologic conditions. In dry hydrologic conditions, storage in all reservoirs, except Donner Lake, is slightly greater under the Fernley scenario than under TROA. Storage in Independence Lake and Prosser Creek Reservoir is greater because releases are slightly less. Stampede Reservoir releases are slightly greater and may account for the greater storage in Boca Reservoir. Greater Lake Tahoe and Stampede Reservoir storage in dry hydrologic conditions is the result of storage of Fernley Municipal Credit Water. In wet hydrologic conditions, the slightly greater total reservoir storage is held in Lake Tahoe. The additional storage is held in Stampede Reservoir from October through November and in Lake Tahoe the remainder of the year in median hydrologic conditions.

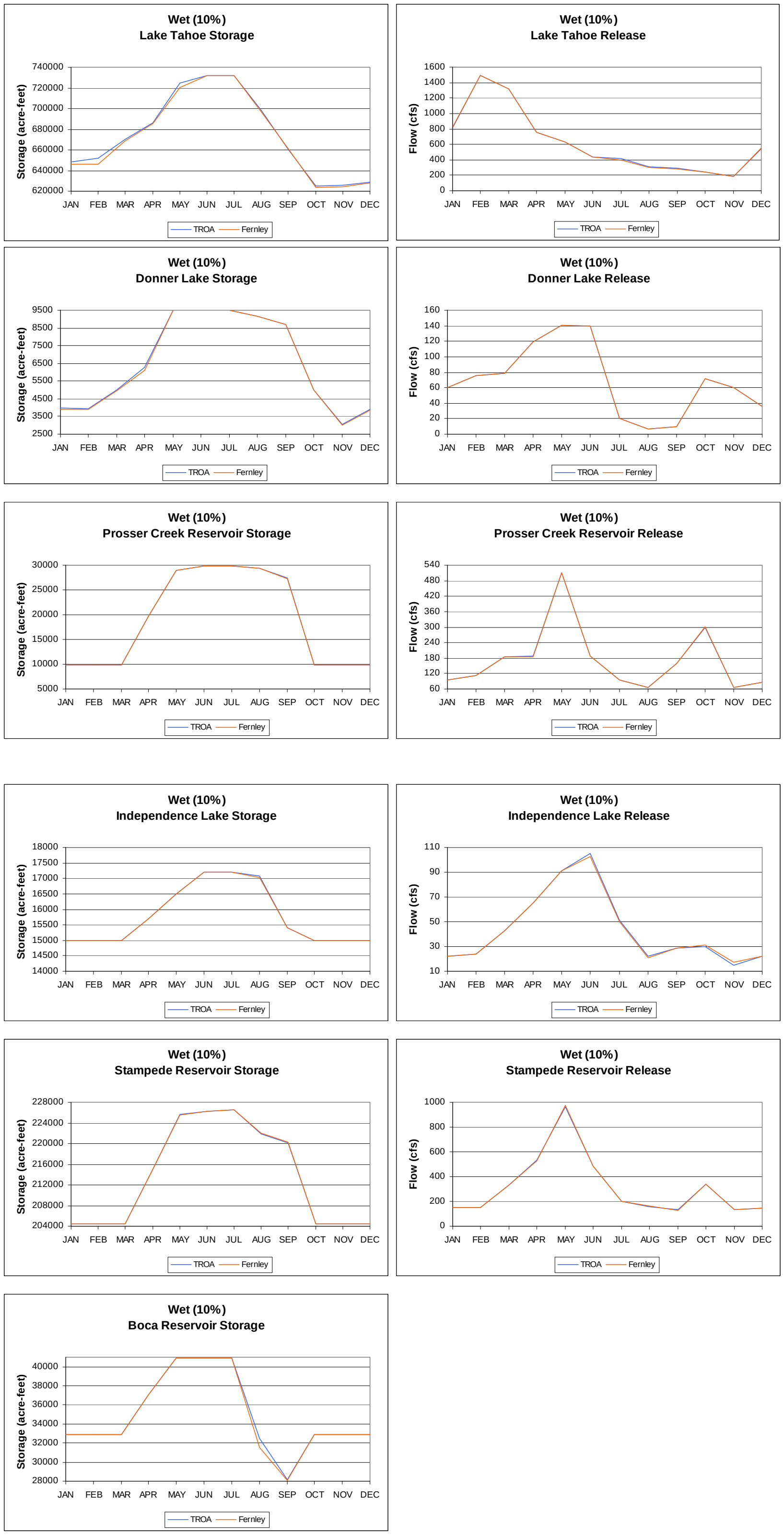


Figure 3.24—Fernley scenario: Operations model results for end-of-month reservoir storage and average monthly releases in wet hydrologic conditions.

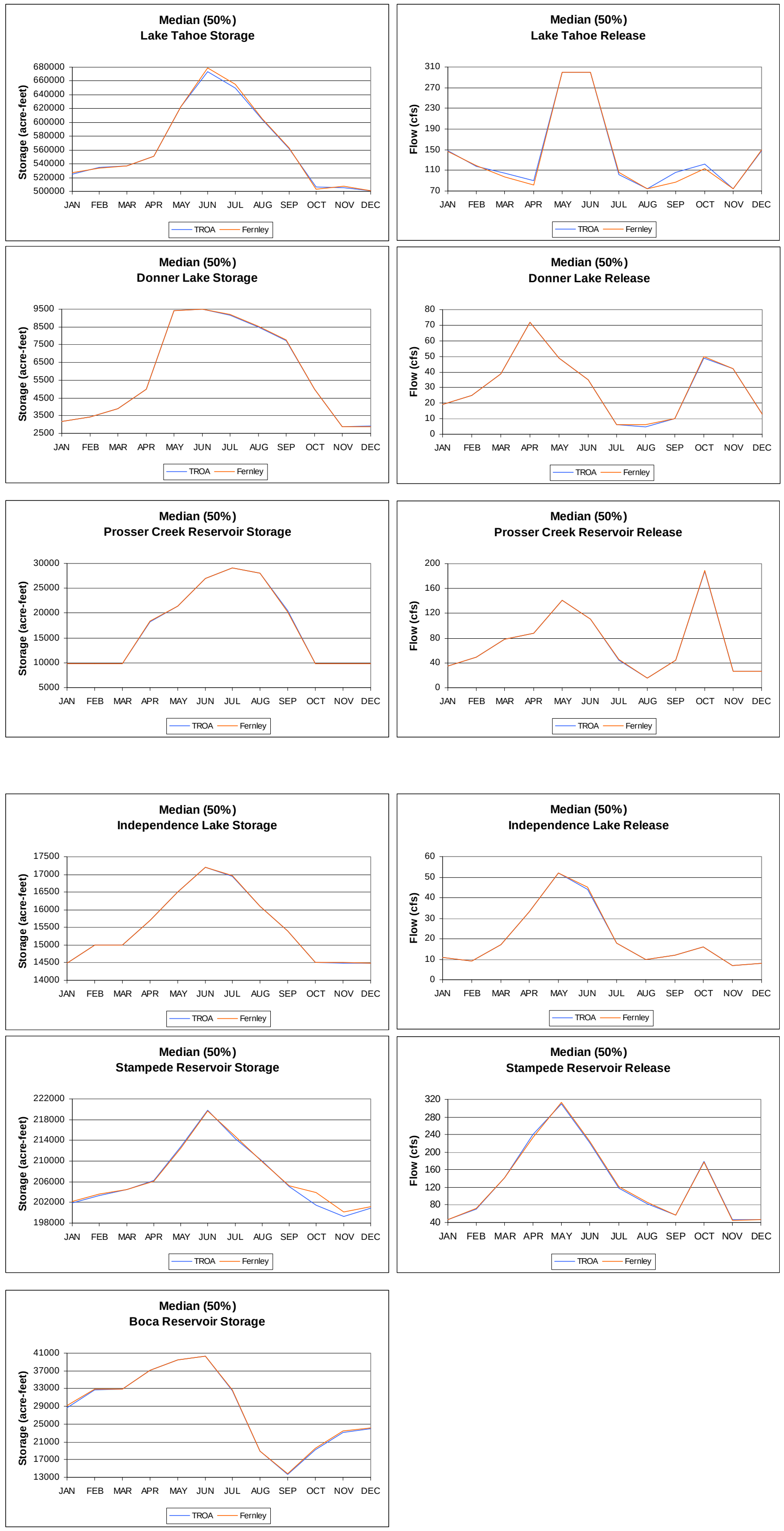


Figure 3.25—Fernley scenario: Operations model results for end-of-month reservoir storage and average monthly releases in median hydrologic conditions.

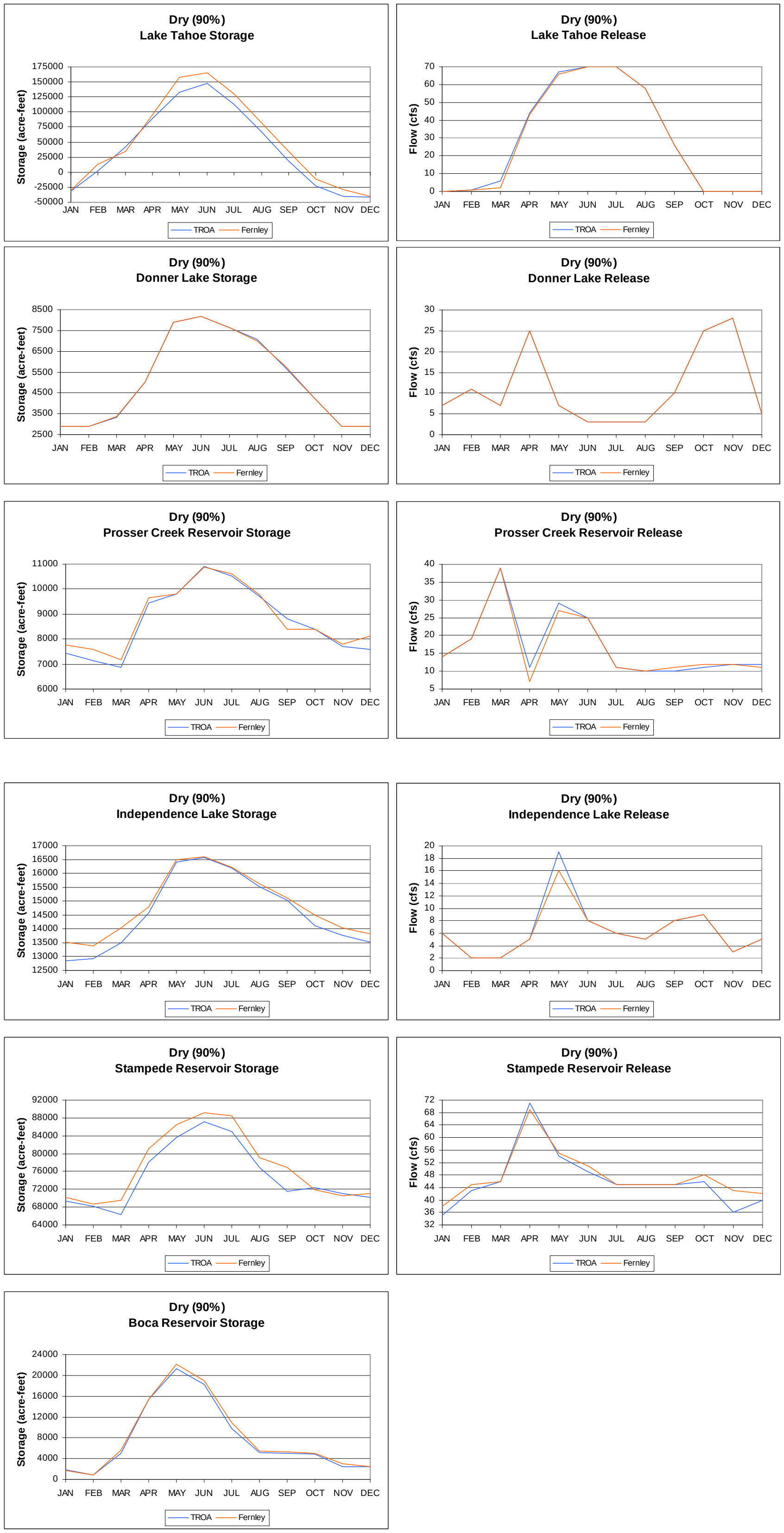


Figure 3.26—Fernley scenario: Operations model results for end-of-month reservoir storage and average monthly releases in dry hydrologic conditions.

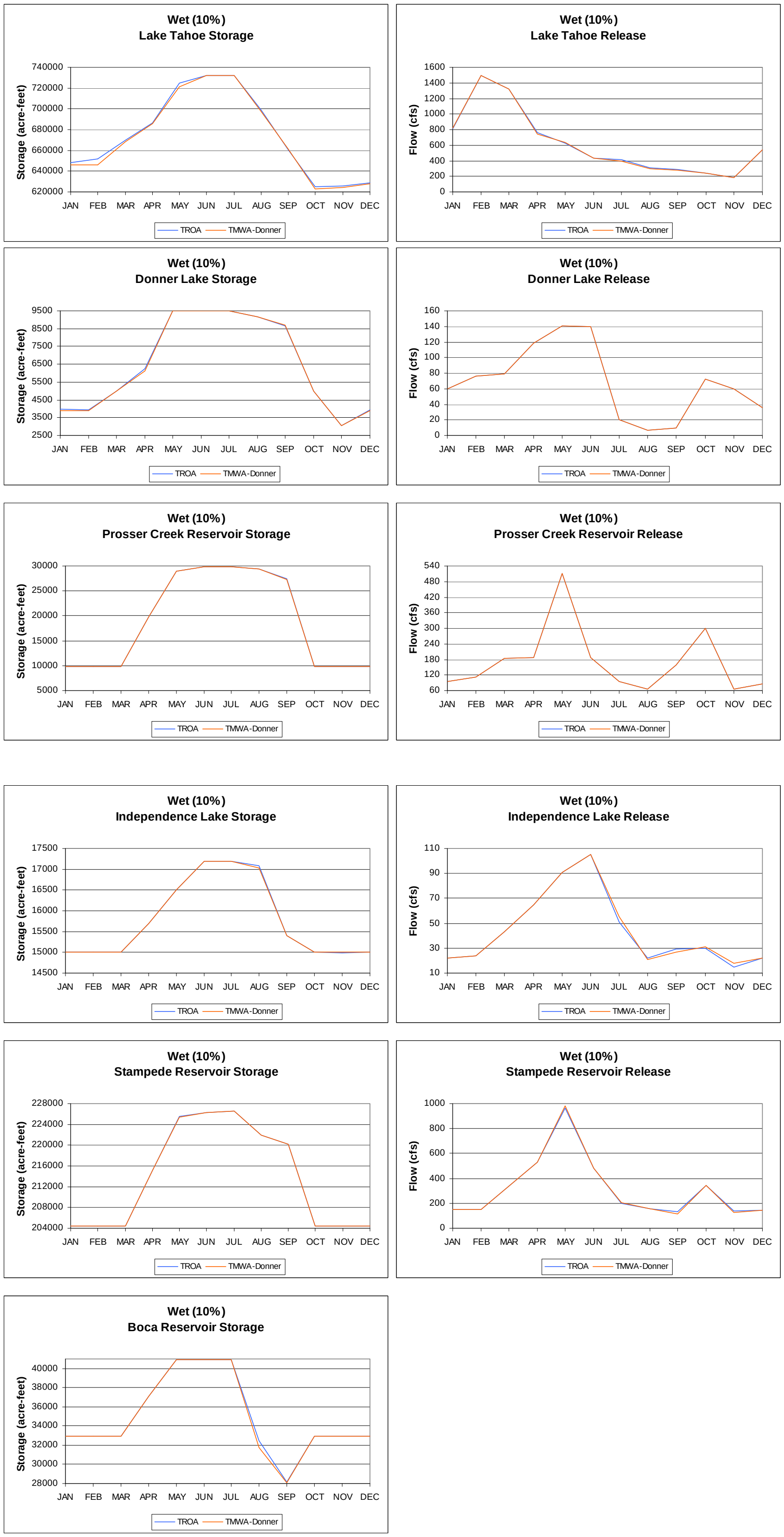


Figure 3.27—Donner-TMWA scenario: Operations model results for end-of-month reservoir storage and average monthly releases in wet hydrologic conditions.

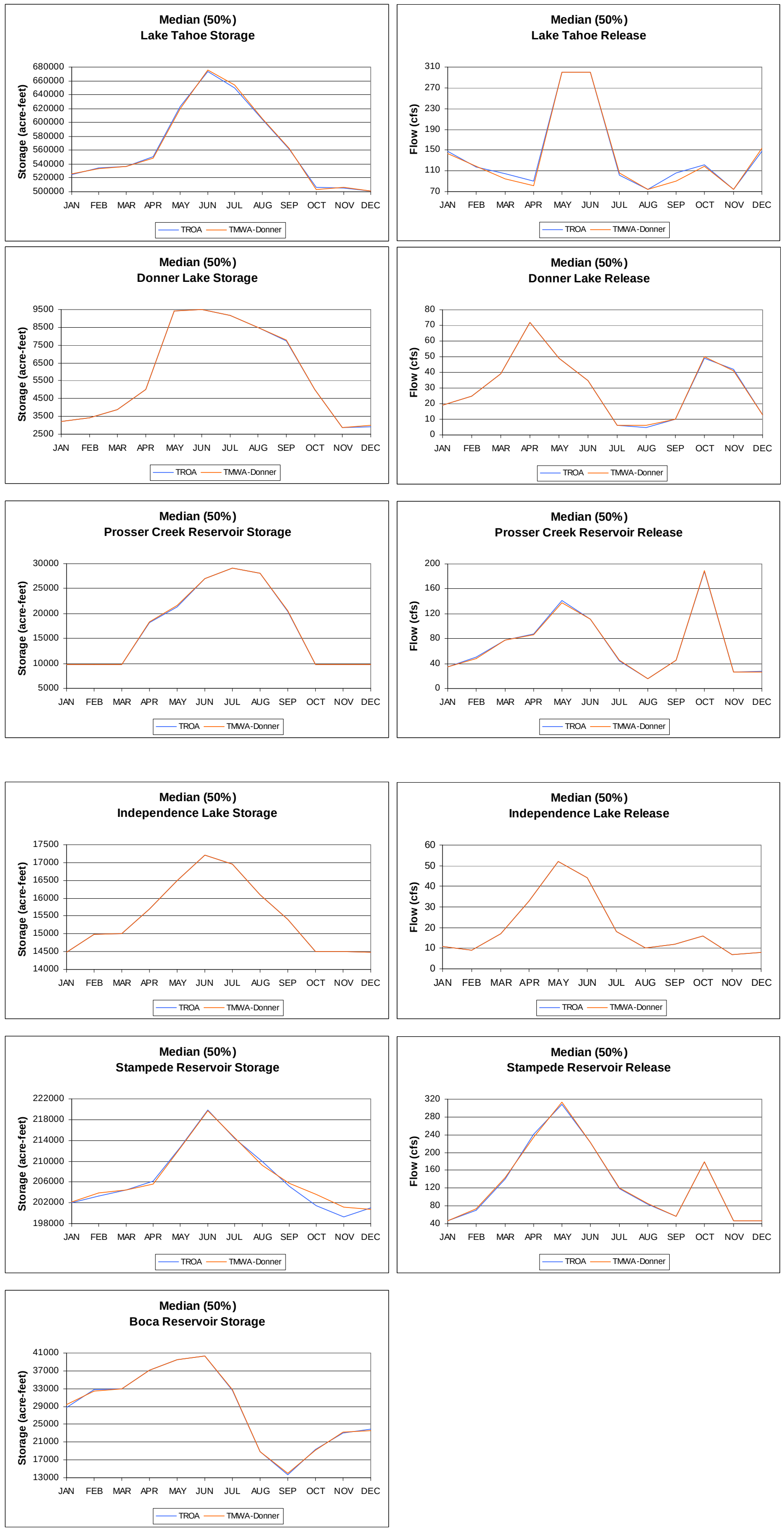


Figure 3.28—Donner-TMWA scenario: Operations model results for end-of-month reservoir storage and average monthly releases in median hydrologic conditions.

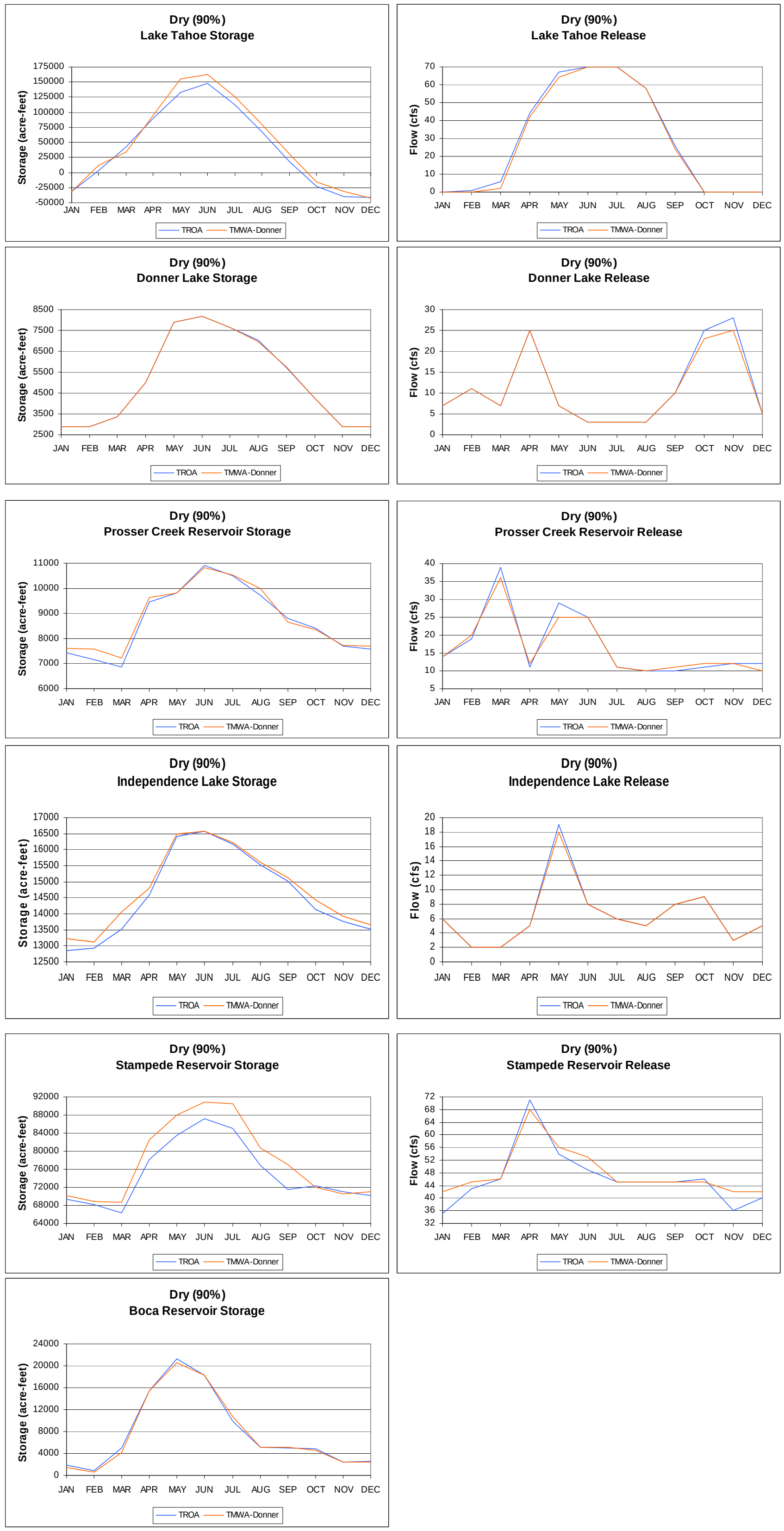


Figure 3.29—Donner-TMWA scenario: Operations model results for end-of-month reservoir storage and average monthly releases in dry hydrologic conditions.

Operations model results show that average annual flow at Farad and Vista is the same under this scenario as under TROA. Flow at Nixon is greater under this scenario because some of the unused portion of Fernley's M&I stored water is either spilled or converted to Fish Credit Water and flows to Pyramid Lake. The flow at Nixon under the Fernley scenario is 694 cfs (2 cfs greater than under TROA) resulting in an additional 1,550 acre-feet per year of inflow to Pyramid Lake.

Agricultural and M&I demands are met to the same degree under this scenario and TROA, except for Carson Division demands. Under the Fernley scenario, the Truckee Canal diverts slightly more water to Lahontan Reservoir and reduces the average annual shortage by 10 acre-feet because of a difference in the timing of Truckee River flows.

Overall, reservoir storage is greater in dry hydrologic conditions and inflow to Pyramid Lake is greater under the Fernley scenario than under TROA. No adverse effects were identified.

b. Donner-TMWA Scenario

Operations model results show that, under the Donner-TMWA scenario, total reservoir storage is slightly less in wet and median hydrologic conditions than under TROA because Truckee River diversions to the Newlands Project are slightly greater. Total reservoir storage is slightly greater under the Donner-TMWA scenario than under TROA in dry hydrologic conditions because of additional storage of TMWA M&I Credit Water (figures 3.27, 3.28 and 3.29). The differences are as follows:

Wet hydrologic conditions	-420 acre-feet
Median hydrologic conditions	-70 acre-feet
Dry hydrologic conditions	930 acre-feet

In dry hydrologic conditions, storage in each reservoir, except Donner Lake and Boca Reservoir, is slightly greater. Storage in Independence Lake is slightly greater, and releases are less because Independence Lake is not used to meet M&I demand as frequently. Storage in Lake Tahoe and Stampede Reservoir is greater in dry hydrologic conditions because of the storage of TMWA M&I Credit Water. On average, under the Donner-TMWA scenario, there is 2,120 acre-feet more TMWA M&I Credit Water than under TROA.

Average annual flows at Farad, Vista, and Nixon under the Donner-TMWA scenario are the same as under TROA.

Agricultural and M&I demands are met to the same degree under the Donner-TMWA scenario and TROA, except for the Carson Division. Under the Donner-TMWA scenario, the Truckee Canal diverts 120 acre-feet per year less water to Lahontan Reservoir. Carson Division average annual shortage is 80 acre-feet per year greater, caused by the loss of the Donner Lake supply.

Under the Donner-TMWA scenario, reservoir storage is slightly greater in dry hydrologic conditions, and supply to the Carson Division is slightly less than under TROA.

H. Sensitivity Scenarios

Following publication of the revised DEIS/EIR, the following additional model runs were made to evaluate the range of opportunities for Credit Water operations under TROA: (1) expanded Newlands credit water storage and (2) implementation of TROA with current conditions.

1. Expanded Newlands Credit Water Storage

a. Method of Analysis and Operations Model Input Assumptions

The method of analysis used for this sensitivity scenario was the same as that used for the alternatives. In addition to No Action and TROA as modeled in the main analysis—i.e., Newlands credit water was not incorporated, and incorporated, respectively—this scenario includes No Action *with* Newlands credit water (NAC) and TROA with *expanded* storage of credit water (TROA-EC).

Operations model input assumptions for NAC and TROA-EC for management of Newlands credit water were as follows:

- Release of Newlands credit water (from Truckee River reservoirs) is restricted to months when total Lahontan Reservoir storage will not exceed the Lahontan Reservoir storage target.

- Under TROA-EC, when Newlands credit water must be reduced because the total of Newlands credit water plus Lahontan Reservoir storage exceeds the storage target or it is the end of the irrigation season, the water is converted to Project Water or Credit Water. Whether the water is converted to Project Water or Credit Water depends on what would have been stored had Newlands credit water not been established; under NAC it is converted to water for cui-ui recovery.

- Under TROA-EC, Newlands credit water can be accumulated adverse to Floriston Rates; under NAC, it cannot be accumulated adverse to Floriston Rates.

- Newlands credit water spills before other waters.

- Newlands credit water may be established when Newlands credit water plus Lahontan Reservoir storage do not exceed the storage targets.

- Newlands credit water is not considered to be Project Water.

- Establishment of Newlands credit water is junior to that of other types of water.

- Under TROA-EC, Newlands credit water may be established in any Truckee River reservoir (Lake Tahoe or Prosser Creek, Stampede or Boca Reservoirs); under NAC, it may only be established in Stampede Reservoir.

- Under TROA-EC, from April through September, Newlands credit water may be exchanged among the Truckee River reservoirs; under NAC, it remains in Stampede Reservoir.

- Under NAC, Newlands credit water is released as needed for the Newlands Project; under TROA, it is released after July 1 to the extent the following limits are not exceeded:

Lake Tahoe	600 cfs
Prosser	150 cfs
Stampede	250 cfs
Farad	600 cfs

- Under TROA-EC, Newlands credit water may be released and diverted as early as April to the extent that the following limits are not exceeded:

  - For April through July:

Lake Tahoe	800 cfs
Prosser	300 cfs
Stampede	600 cfs
Farad	1000 cfs

  - For August through October:

Lake Tahoe	600 cfs
Prosser	120 cfs
Stampede	400 cfs
Farad	700 cfs

b. Model Results and Evaluation of Effects

Reservoir storage and releases and flows at Farad and Nixon in wet, median, and dry hydrologic conditions are shown in the Water Resources Appendix, Exhibit 20. Newlands Project shortages for the Carson Division are shown in figure 3.30. Exhibit 21 in the Water Resources Appendix shows operations model results for Lake Tahoe and Stampede

Reservoir releases and Farad flows for the example of storing a large amount of Newlands credit water.

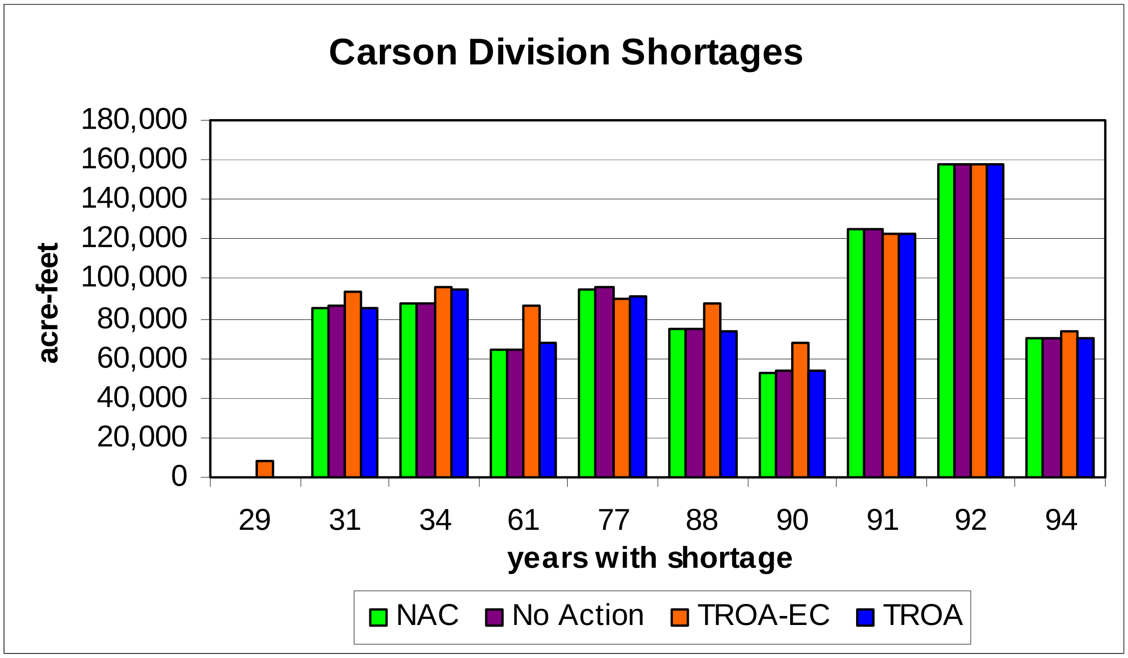


Figure 3.30—Expanded Newlands credit water scenario: Operations model results for Carson Division shortages.

Operations model results show that, under TROA, Newlands credit water is created in 21 years with a maximum storage of 1,300 acre-feet. Under TROA-EC, Newlands credit water is stored in 41 of the 100 years of analysis, with an average storage of 18,000 acre-feet and a maximum storage of 45,000 acre-feet. Under NAC, Newlands credit water is stored in 13 of the 100 years of analysis, with an average storage of 10,000 acre-feet and a maximum storage of 38,000 acre-feet. The fundamental difference between TROA and TROA-EC and NAC is that under TROA, there are more opportunities to establish Newlands credit water (e.g., it can be established adverse to Floriston rates and in other Truckee River reservoirs) and exchange Newlands credit water between reservoirs. For example, under TROA, Newlands credit water could be established or exchanged into Lake Tahoe when Stampede Reservoir is at or near capacity, which is not an option under No Action or NAC. Under NAC, it is possible to store a similar amount as under TROA through an exchange involving reducing diversions to the Truckee Canal, allowing the amount of water which could have been diverted to the Truckee Canal to flow to Pyramid Lake, and converting Fish Water in Stampede Reservoir in the amount of the diversion foregone to Newlands credit water.

In general, operations model results show that in median and dry hydrologic conditions there is more storage in Stampede Reservoir under TROA-EC than under TROA and less storage in Lahontan Reservoir when Newlands credit water is stored from December through June. The effect on Lahontan Reservoir storage may extend into the fall and, possibly, following years because, unlike current conditions, OCAP storage targets are less likely to be exceeded with the Newlands credit water operation and carryover storage is less likely to be available. This carryover storage may remain in Truckee River reservoirs (Newlands credit water converts to Fish Credit Water at the end of the irrigation season), resulting in greater storage in Stampede Reservoir and less storage in Lahontan Reservoir.

Operations model results show that average storage in Stampede Reservoir is greater under both NAC (1,000 acre-feet/year) and TROA-EC (4,000 acre-feet/year) than under No Action and TROA, respectively, because of the additional availability of Newlands credit water. Operations model results also show that flows at Farad and Nixon in dry hydrologic conditions in the late summer are not affected because Newlands credit water is only stored when an average-to-above-average flow year is forecast.

Because less water is diverted to Lahontan Reservoir under Newlands credit water operations, average Lahontan Reservoir storage is less and inflow to Pyramid Lake is greater than under either No Action or TROA. Pyramid Lake inflow is 1,330 acre-feet per year greater, and Lahontan Reservoir storage is 5,000 acre-feet per year less under TROA-EC storage than under TROA. Pyramid Lake inflow is 80 acre-feet per year greater, and Lahontan Reservoir storage is 1,000 acre-feet per year less under NAC than under No Action.

Operations model results show that Carson Division shortages (figure 3.30) occur in the same 9 years and are of similar magnitude for the respective years under TROA, No Action, and NAC. Under TROA-EC, One additional shortage year (of 8,000 acre-feet) occurs under TROA-EC, and in the other 9 shortage years, shortages are the same in one year and greater in the other eight years (differences ranging from 1,000 to 18,000 acre-feet) compared to TROA. Greater shortages occur under TROA-EC because less carryover storage is available in Lahontan Reservoir.

An additional analysis focused on those years in which a large amount of Newlands credit water is stored. Figure 3.31 shows data from the 10 years with the greatest storage (an annual average of approximately 35,000 acre-feet) of Newlands credit water and averages the storage in and releases from Lake Tahoe and Stampede Reservoir, storage in Lahontan Reservoir, and flows at Farad for these years. At Lake Tahoe and Stampede Reservoir, storage of a large block of Newlands credit water results in greater storage and smaller reservoir releases from December through the spring runoff under TROA-EC than under No Action and TROA. After the spring runoff, releases are greater under TROA-EC due to the release of Newlands credit water. Farad flow, corresponding to upstream water availability, is less from December through the spring runoff and greater during the summer than under No Action or TROA. Storage of Newlands credit water in Truckee River reservoirs results in less Lahontan Reservoir storage during the summer

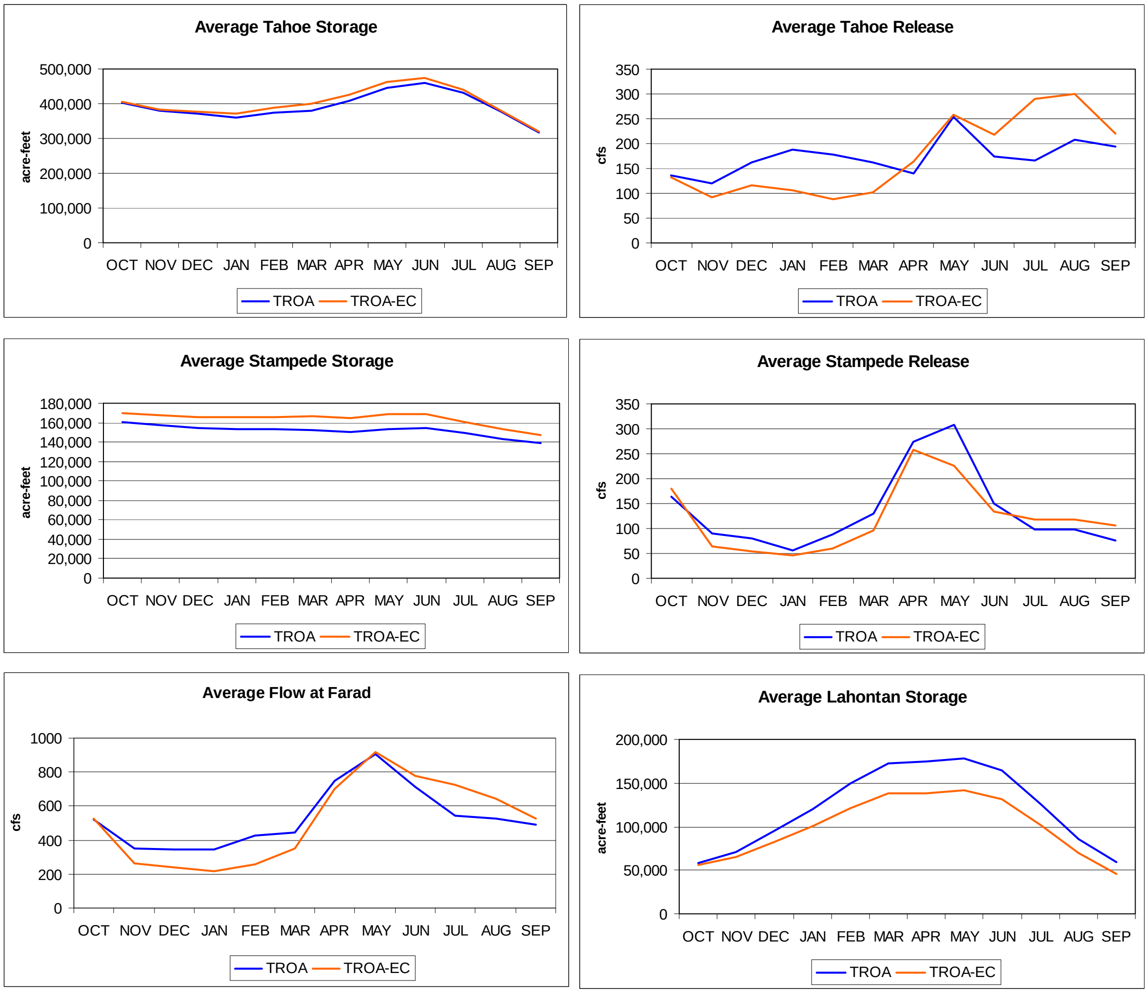


Figure 3.31—Expanded Newlands credit water scenario: Operations model results for selected parameters for years with the 10 largest amounts of Newlands credit water stored.

months than under TROA. Effects on Lahontan Reservoir under NAC would be similar to those under TROA-EC if 35,000 acre-feet of Newlands credit water were stored, except Lake Tahoe would not be affected because Newlands credit water is only stored in Stampede Reservoir under NAC.

Shortages are likely to be greater under expanded credit storage operations because the end-of-June Lahontan Reservoir storage objective is less likely to be exceeded; as a result, the amount of carryover storage (i.e., water in excess of the November storage target) is likely to be less. Shortages do not occur in years when credit storage operations are implemented, however, and the effects of shortages are exacerbated only to the extent that carryover potential is diminished. Real-time operations will likely vary seasonally and annually depending on water availability and coordination of scheduling.

2. Implementation of TROA with Current Conditions

This scenario was modeled to evaluate the potential differences between implementation of TROA with current conditions and full implementation of TROA in the future, with emphasis on Truckee River flows and diversions to the Newlands Project.

a. Method of Analysis and Model Input Assumptions

The same methods of analysis were used as described for the analysis of "Reservoir Storage and Releases," "Flows," and "Exercise of Water Rights to Meet Demand," except this scenario compared the differences in operations model results between current conditions and current conditions with TROA (CCT) (i.e., current condition runs) to the differences between No Action and TROA (i.e., future condition runs). This comparison provides perspective on the effects of demographic change over time.

Current conditions, No Action, and TROA are the same as described previously. For this scenario, consumptive demands are the same as those for current conditions; assumptions for minimum flows, preferred and enhanced minimum flow targets, hydroelectric power bypass requirements, and recreational pool targets are the same as those for TROA, except for the following:

- As under current conditions, there is no California M&I Credit Water because all demands are met, and annual California M&I demand from Truckee River surface water is 2,800 acre-feet, leaving 7,200 acre-feet of Joint Program Water for use by California.

- For the 6,700 acre-feet of Truckee Meadows water rights to be provided by Reno, Sparks, and Washoe County for Water Quality Water under TROA, it is assumed that 4,900 acre-feet would be acquired from direct irrigation rights and 1,800 acre-feet from lands receiving treated sewage effluent. This acquisition reduces the diversion from the Truckee River to Truckee Meadows irrigation by 8,310 acre-feet (4,900 acre-feet of irrigation plus 3,410 acre-feet of losses), from 40,770 acre-feet to 32,460 acre-feet. It is also assumed 4,900 acre-feet of sewage effluent (the return flow from the wastewater groundwater component) is land-applied, reducing the annual discharge from TMWRF from 29,710 acre-feet to 24,810 acre-feet.

b. Model Results and Evaluation of Effects

Reservoir storage and releases in wet, median, and dry hydrologic conditions for current conditions, CCT, No Action, and TROA are shown in the Water Resources Appendix, Exhibit 22. Operations model results for Truckee Division and Carson Division shortages are shown in figure 3.32 and figure 3.33.

Operations model results for CCT and TROA are very similar except for (1) Truckee River flows from Farad to Derby Diversion Dam, (2) Newlands Project diversions (Truckee Division and Carson Division), and (3) inflow to Pyramid Lake.

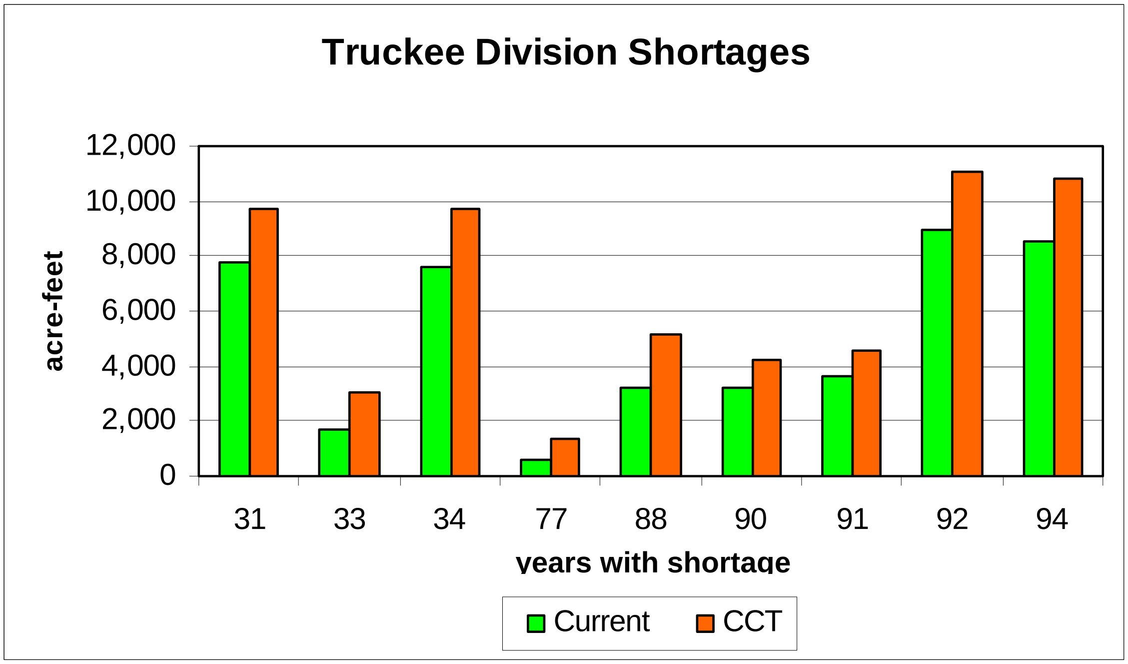


Figure 3.32—Implementation of TROA with current conditions scenario: Operations model results for Truckee Division shortages.

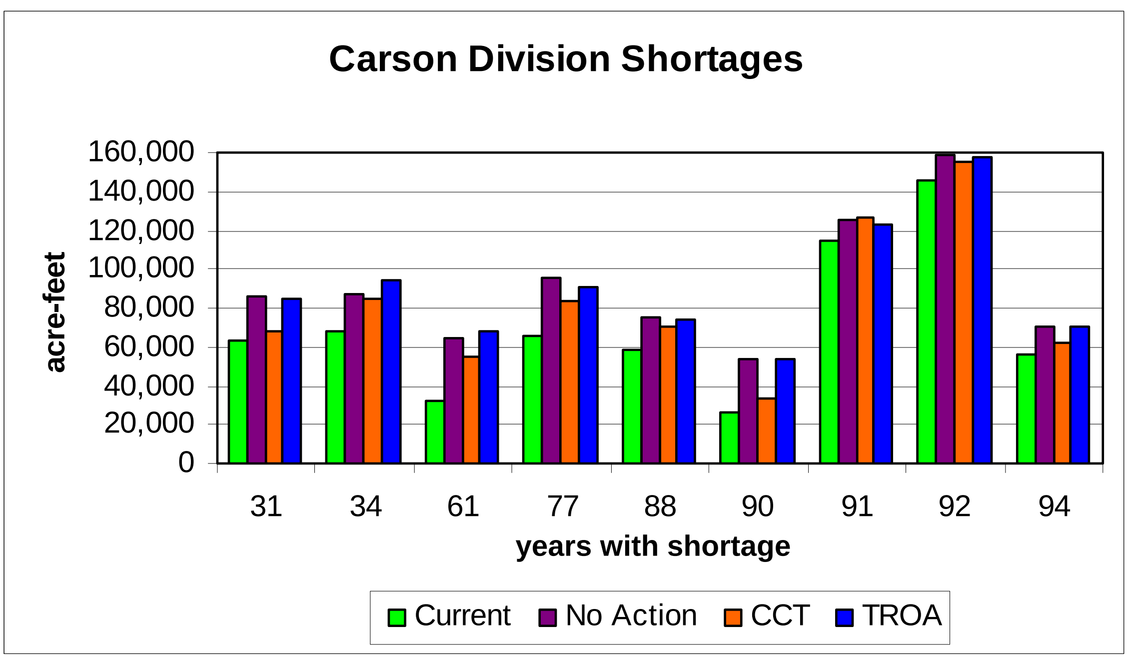


Figure 3.33—Implementation of TROA with current conditions scenario: Operations model results for Carson Division shortages.

Differences in Truckee River flows between Farad and Derby in August and September vary between the current and future condition runs. In dry hydrologic conditions, Truckee River flows at Vista are slightly less under CCT than under current conditions. Under TROA, flows at Vista are greater than under No Action because of the availability of more Water Quality Credit Water and Fish Credit Water, exercise of Claim Nos. 1 and 2 of the *Orr Ditch* decree, and less irrigation use in Truckee Meadows and the Newlands Project. Under CCT, flows at Vista are less because only 6,700 acre-feet of Water Quality Water is assumed to be provided; Claim No. 2 is not being exercised; less Fish Credit Water is available; and more irrigation demand is assumed in Truckee Meadows and the Newlands Project. In addition, under CCT, less water is available at Vista than under current conditions because 6,700 acre-feet of sewage effluent is land-applied instead of discharged directly to the Truckee River. In dry hydrologic conditions, the 6,700 acre-feet of sewage effluent is still land-applied, while only a portion of the water associated with the 6,700 acre-feet of water rights purchased as a condition of TROA is available for use. As a result, flows at Vista are slightly less under CCT than under current conditions.

Operations model results presented in figures 3.32 and 3.33 show the years when shortages occur in the Truckee and Carson Divisions of the Newlands Project. No Truckee Division results are shown for the alternatives because, in the future, it is assumed that all Truckee Division water rights would be acquired for Fernley M&I and water quality improvement purposes. Greater shortages occur under CCT than under current conditions because upstream water right owners are able to store water which, without TROA, they might be unable to divert and, so, the water would continue to flow. In other words, water that previously may have been available for diversion to the Newlands Project may no longer be available because, under TROA, upstream parties can exercise their water rights more effectively and fully.

Operations model results show that Carson Division shortages are slightly greater under CCT than under current condition. The difference in shortages is greater for current condition, because, although TMWA's irrigation rights are assumed to be the same, TROA initially (under CCT) allows more efficient use of upstream water rights, thus reducing water availability downstream. TROA provides that TMWA purchase 1.11 acre-feet of water rights for each acre-foot of new service commitment and use the savings from a water meter retrofit program for drought supply. Once fully implemented, more Truckee Meadows irrigation water rights would be purchased under TROA than No Action. A reduction in irrigation delivery under TROA would reduce depletions (by reducing canal losses) and increase water availability downstream (including to the Newlands Project) compared to No Action.

Operations model results indicate that, under TROA, the elevation of Pyramid Lake at the end of the period of analysis is approximately 2.5 feet higher than under No Action, about 1.5 feet higher than under current conditions, and about 1 foot higher than under CCT. See figure 3.34.

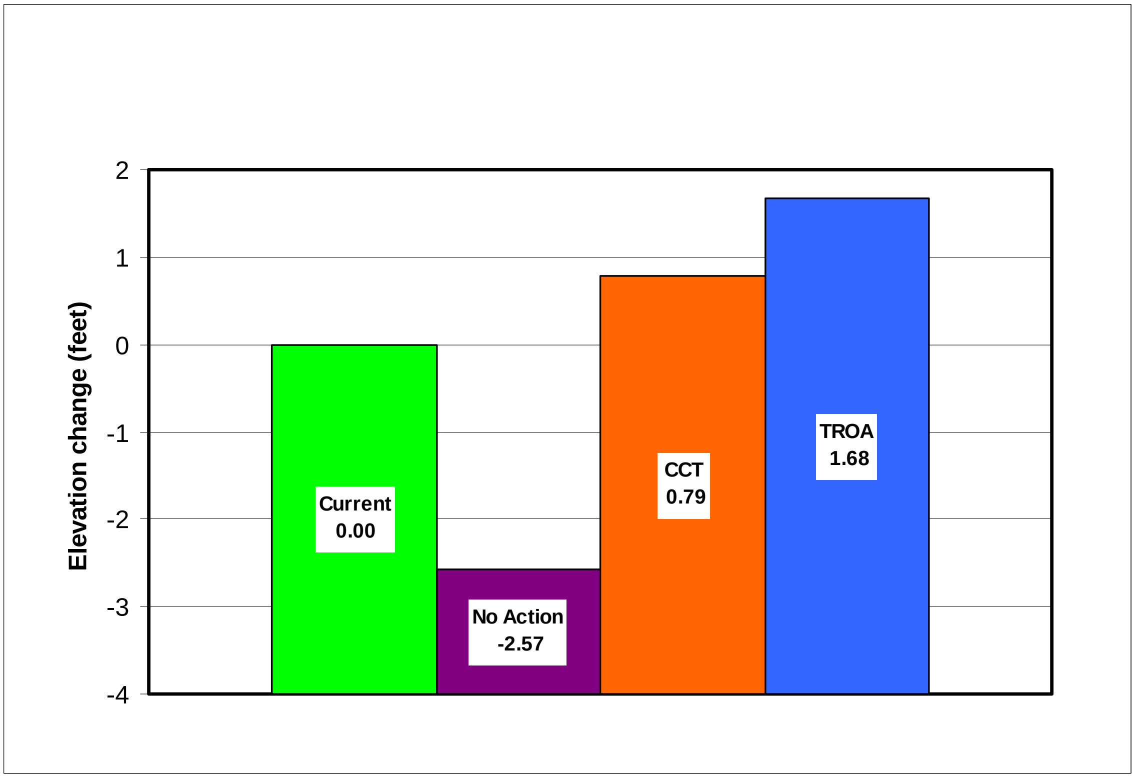


Figure 3.34—Difference between current conditions and No Action, CCT, and TROA in operations model results for the elevation of Pyramid Lake at the end of the period of analysis.

As discussed previously, programs under TROA assumed to produce additional inflow—the 1.11 acre-feet of water rights for each acre-foot of commitment by TMWA, the water meter retrofit program in Truckee Meadows dedicated to drought storage, as well as the Water Quality Credit Water program—are not fully implemented under CCT.

I. Credit Waters Not Modeled

Because of their speculative nature, California Environmental Credit Water, Additional California Environmental Credit Water, and Other Credit Water were not included in the operations model. It is possible, however, to characterize the use of these credit waters across a range of reasonably foreseeable scenarios. In each case, an uncertain amount of additional water, limited by the constraints in TROA, would be stored in upstream reservoirs for some period of time. Consequently, more water would be stored in the upstream reservoirs at various times under TROA than without TROA. Additional water in the reservoirs translates into additional recreational opportunity in those reservoirs. While flow in a portion of the Truckee River (and possibly a tributary) would be less when water is being stored, it would be greater when the water is released.

In the case of the two categories of California Environmental Credit Water, California specifically sought to reserve such storage opportunities during the TROA negotiations to improve flows within California for fish. Releases of that water would continue past the State line, thus also benefiting fish in Nevada. Also, California would use this water specifically for environmental purposes, and the uses are non-consumptive except for a small share of evaporation (which minimizes total flow impacts in Nevada). California would have the right and responsibility for optimizing the trade-offs and timing among storing its water rights versus letting the water flow to improve streamflows, retaining water in the reservoirs for recreation, and releasing water to increase streamflows. California M&I water storage could substitute for some diversions of surface water or use of groundwater in the basin for M&I use and, while in storage, would enhance recreational opportunity to a limited extent. (This category is limited to 3,000 acre-feet in most reservoirs, so the effect would be small). California Environmental Credit Water, together with California M&I Credit Water, could be stored up to a total of 8,000 acre-feet, of which 3,000 acre-feet may be stored in Truckee River reservoirs other than Lake Tahoe. Additional California Environmental Credit Water could be stored—up to 10,000 acre-feet at any one time. They were not modeled or analyzed in the EIS/EIR because their establishment is contingent on the purchase of water rights and the prospects for their future use are uncertain.

Other Credit Water, also addressed in the negotiated TROA, would be the lowest priority Credit Water managed pursuant to TROA. There are no proposals or assumptions for its use, and it was not included in model operations.

The establishment, storage, and release of each of these Credit Water categories may require further analysis under NEPA and/or CEQA. It is possible that some of these Credit Waters may never be used, but California assumes that Credit Water could be expected to be used for M&I storage.

GROUNDWATER

I. Affected Environment

This section provides an overview of groundwater supplies and demand in the study area.

In the California portion of the Truckee River basin, there is no regulatory limit on the right to pump groundwater. Under TROA, groundwater pumping would be limited to 32,000 acre-feet per year, less whatever surface water is diverted. (Under P.L. 101-618, surface water use currently is limited to 10,000 acre-feet per year.) In California's Martis Valley basin, the largest portion of the Truckee River basin in California, estimated groundwater recharge is about 34,600 acre-feet per year (Nimbus, 2001). Groundwater levels in wells adjacent to the Truckee River are higher than the river, which indicates that groundwater is moving into the river (Nimbus, 2001). In this setting, changes in riverflows would have very little effect on adjacent groundwater levels.

Although low-yield, private wells serve individual residences throughout the Truckee River basin, most groundwater pumping occurs in Truckee Meadows, where municipal water purveyors, such as TMWA, operate production wells to supplement the surface water supply. TMWA has 33 production wells, 22 of which are fitted for pumping and recharge (TMWA, 2003). Estimated groundwater recharge in Truckee Meadows is 29,000 acre-feet per year and comes from infiltration of precipitation (mainly snowmelt); return flows from surface water supplies used for irrigation; and seepage from ditches, canals, and streambeds. The total permitted, certificated, and vested groundwater rights recognized in Truckee Meadows by the State Engineer's Office are 79,765 acre-feet per year, or about 50,000 acre-feet per year more than the perennial yield. TMWA holds certificated and permitted groundwater rights in Truckee Meadows to divert up to 41,811 acre-feet per year.

In the Newlands Project, where the introduction of irrigation to Lahontan Valley resulted in substantial recharge of the shallow aquifer from canal seepage and irrigation losses, numerous domestic wells pump water from the shallow aquifer (USGS, 1993). Truckee River water is diverted into the Truckee Canal at Derby Diversion Dam for irrigation in the Truckee Division and for delivery to Lahontan Reservoir. Newlands Project OCAP has been promulgated to meet project irrigation requirements consistent with the *Orr Ditch* and *Alpine* decrees while minimizing use of Truckee River water and maximizing use of Carson River water for project purposes. Generally, diversion of Truckee River water to the Truckee Division varies directly with demand; diversion to the Carson Division depends in large part on Carson River inflow to Lahontan Reservoir.

In 1996, USGS estimated as many as 4,500 domestic wells could pump water from the shallow aquifer around the Fallon area. The Churchill County Assessor database shows that, as of April 2005, 4,814 wells were in use in the county. Because the wells generally are shallow (less than 150 feet deep), they are dependent on surface water recharge, primarily from canal seepage and irrigation losses. No measurement of the shallow aquifer recharge is available. However, estimated groundwater recharge for the Fallon area is 56 percent from canal seepage, 37 percent from irrigation losses, 5 percent from precipitation, and 2 percent from Newlands Project drains (USGS, 2000). Similarly, between Fallon and Stillwater WMA, estimated recharge is 47 percent from canal seepage, 40 percent from irrigation losses, 5 percent from precipitation, and 8 percent from Newlands Project drains. These estimates provide a relative degree of recharge that can be expected near irrigation facilities in this area.

Groundwater use in the Newlands Project could be affected by changes (decreases or increases) in the amount of water conveyed in canals and laterals. Current water rights programs involving the Newlands Project, including WQSA, WRAP, and Assembly Bill 380, would result in a reduction of irrigated acreage. NEPA compliance activities have been completed on these programs. For this analysis, future changes in the disposition and exercise of Truckee Division and Carson Division water rights were assumed to be implemented independent of TROA. Thus, water rights acquisition programs under the alternatives were assumed to be identical, and canal deliveries under the alternatives would be less than under current conditions.

Truckee Division irrigation is dependent on diversions from the Truckee Canal. Recharge of the local aquifer near the Truckee Canal is influenced by seepage losses from the canal. The general estimate of all losses from canals, spills, and on-farm irrigation losses is 64 percent of the diversion supply (CH2M Hill, 1973). Changes in canal seepage related to changes Truckee Canal flows could affect recharge of the local aquifer.

Water deliveries from Lahontan Reservoir to the Carson Division (that would support canal seepage and irrigation) are similar under all alternatives. The most recent study on the influence of changing irrigation practices is a modeling effort by USGS, which provides an indication of the order of magnitude of change expected in the shallow aquifer. USGS Water Resources Investigation Report 99-4191, prepared in cooperation with Reclamation, *Conceptual Evaluation of Ground-Water Flow and Simulated Effects of Changing Irrigation Practices on the Shallow Aquifer in the Fallon and Stillwater Areas, Churchill County, Nevada*, indicates changes for various irrigation and seepage reductions. The range of water level decline for the various scenarios modeled, including reductions in irrigated acreage, shows maximums between 2.6 and 10.3 feet. It should be noted that for this EIS/EIR, changes to irrigation and seepage losses are expected to occur between current conditions and No Action, and not between No Action and LWSA or TROA. For this reason, no further groundwater analysis for the Carson Division was required.

II. Environmental Consequences

A. Introduction

The operations model does not incorporate groundwater dynamics and it does not address the number of wells, their locations, amounts of groundwater recharged, or any surface water-groundwater interface. Therefore, a qualitative analysis was conducted to evaluate the effects of modifying operations of Truckee River reservoirs on groundwater using the following indicators:

- Recharge of the shallow aquifer adjacent to the Truckee River, as assessed estimated stream losses in the Oxbow reach of the Truckee River (Hunter Creek to Highway 395, shown on map 3.1)

- Recharge of the shallow aquifer in Truckee Meadows, as assessed by transfer of agricultural water rights to M&I use in the future and projected groundwater pumping

- Recharge of the shallow aquifer near the Truckee Canal, as assessed by average annual diversions to the Truckee Canal at Derby Diversion Dam, the resulting Truckee Canal inflow to Lahontan Reservoir, Lahontan Reservoir storage and releases to the Carson Division, and estimated losses from the Truckee Canal

- Groundwater pumping in the Truckee River basin in California and Truckee Meadows in Nevada

B. Summary of Effects

Operations model results show no major differences in Truckee River flows through Truckee Meadows among the alternatives; therefore, recharge of the shallow aquifer adjacent to the Oxbow reach would not be affected. Effects on recharge of the shallow aquifer in Truckee Meadows and establishment of a new groundwater equilibrium would vary slightly among the alternatives and depend upon many local factors, such as the amount of groundwater pumping, recharge, and the localized groundwater flow gradients. In the Truckee Division, total diversions into the Truckee Canal and, therefore, seepage losses from the Truckee Canal, would be similar under all alternatives. With criteria established for new well construction in California under TROA, assumed limitations on groundwater use, and development of surface water drought supplies, TROA likely would have the least effect on future groundwater resources among the alternatives. Table 3.21 summarizes the effects of the alternatives on groundwater.

Table 3.21—Summary of effects on groundwater

Indicator	Current conditions	No Action	LWSA	TROA
Recharge of aquifer adjacent to Truckee River in the Oxbow reach	Not quantified	Slightly less than under current conditions	Same as under No Action	Slightly more than under No Action; same as under current conditions
Recharge of the shallow aquifer in Truckee Meadows	Not quantified	Slightly less than under current conditions	Same as under No Action	Less than under No Action; much less than under current conditions
Recharge of shallow aquifer near Truckee Canal due to seepage losses	Not quantified	Much less than under current conditions	Slightly less than under No Action; much less than under current conditions	Slightly more than under No Action; much less than under current conditions
Groundwater pumping in the Truckee River basin in California (acre-feet per year)	7,750	19,600	18,400	Less than under No Action; much more than under current conditions
Groundwater pumping in Truckee Meadows	15,350 acre-feet average annual modeled pumping	Less than under current conditions	Slightly more than under No Action; less than current conditions	Less than under No Action; less than under current conditions

C. Recharge of the Shallow Aquifer Adjacent to the Truckee River in the Oxbow Reach

1. Method of Analysis

The Truckee River can have a component of seepage losses to the adjacent shallow aquifer, although some reaches, where the river channel is incised in rock or dense soils, have no (or very little) seepage. Conversely, some reaches of the Truckee River receive groundwater flow, or are “gaining,” when the water level of the adjacent shallow aquifer is higher than that of the river channel.

For this analysis, the Oxbow reach of the Truckee River was used to compare flows and the associated potential for recharge (i.e., stream losses) of the adjacent shallow aquifer. The Oxbow reach was selected because it provides a setting where the river water level interacts with the adjacent water table (groundwater levels). Estimated stream losses are representative of water that becomes groundwater (i.e., “recharges the aquifer”) when the adjacent shallow aquifer is both connected to the stream and has water elevations lower than the stream.

Flows in the Oxbow reach were generated from the operations model for current conditions and the alternatives in wet, median, and dry hydrologic conditions, and potential annual stream losses were estimated from these flows. Estimated stream losses were calculated simply as a percent of flows applied to the monthly flows.

This shallow aquifer is complex, with abrupt vertical and horizontal changes in lithology,[5] and estimating changes to it on the basis Truckee River flows is difficult (USGS, 1986). River and aquifer interactions also are complex, but have been simplified to the assumption that less water in the river means less water available to provide aquifer recharge through stream losses (USGS, 1986).

2. Threshold of Significance

Because insufficient information is available to determine a numeric threshold significance, this analysis provides a subjective assessment of the relative differences in stream losses among alternatives.

3. Model Results

Table 3.22 compares average annual stream losses in the Oxbow reach of the Truckee River in wet, median, and dry hydrologic conditions. Stream losses were estimated from average monthly flows generated from the operations model.

Table 3.22—Comparison of potential annual stream losses estimated from average monthly flows, in Oxbow reach of the Truckee River

Hydrologic condition	Current conditions	No Action	LWSA	TROA
Wet	Not modeled	4 percent less than under current conditions	Same as under No Action	4 percent more than under No Action; same as under current conditions
Median	Not modeled	6 percent less than under current conditions	Same as under No Action	Same as under No Action
Dry	Not modeled	5 percent less than under current conditions	1 percent less than under No Action; 6 percent less than under current conditions	1 percent more than under No Action; 4 percent less than under current conditions

[5] Structure and composition of sediments and rock formations.

4. Evaluation of Effects

a. No Action

Analysis shows average annual stream losses under No Action are 4 to 6 percent less than under current conditions. These differences are very small and are not expected to affect recharge of the adjacent shallow aquifer.

b. LWSA

Average annual stream losses under LWSA could be 1 percent less than under No Action and 4 to 6 percent less than under current conditions. These differences are very small and are not expected to affect recharge of the adjacent shallow aquifer. Similarly, considering the change in flow depth, no discernible change is expected in stream losses.

c. TROA

Overall, in wet, median, and dry hydrologic conditions, potential stream losses to the adjacent aquifer under TROA range from 6 percent less to 5 percent more than under No Action or current conditions. These differences are very small and are not expected to affect recharge of the adjacent shallow aquifer. The monthly flow pattern under TROA could result in some small, short-term changes compared to No Action and current conditions; however, the local aquifer response is not immediate and depends upon other variables. The short-term changes would be a result of differences in monthly flows rather than total annual flows.

Flow depth under TROA is 2 percent shallower to 1 percent deeper than under No Action or current conditions. Because of the many natural variables within the stream/aquifer setting, the estimated differences in stream losses are not expected to result in any measurable change to the adjacent shallow aquifer.

5. Mitigation

No mitigation would be required because no significant adverse effects have been identified under any of the alternatives.

D. Recharge of the Shallow Aquifer in Truckee Meadows

1. Method of Analysis

This analysis evaluated the effects of transferring agricultural water rights to M&I use in Truckee Meadows. The effects on recharge of the shallow aquifer can be described only in general terms because of many variables, such as location of irrigated fields, number of existing wells, type of aquifer, depth of wells, types of crops, and variations in soils and aquifer material.

2. Threshold of Significance

Because of the many variables associated with the transfer of agricultural water rights in Truckee Meadows, this analysis provides a subjective assessment of their effects on recharge of the shallow aquifer.

3. Model Results

Currently, TMWA has accumulated 57,170 acre-feet of former irrigation water rights. Under No Action and LWSA, it is anticipated that developers would provide an additional 25,860 acre-feet. Due to the 1.11:1.00 ratio applied to water rights transferred under TROA, an additional 10,520 acre-feet is assumed to be transferred under TROA. Because of these transfers, less water would be applied to croplands and less water would pass through the crop rootzone to recharge the shallow aquifer. The operations model includes the irrigation diversions to Truckee Meadows. Average annual irrigation diversions under No Action and the LWSA are 20,720 acre-feet. Under TROA, the average annual irrigation diversion is 4,690 acre-feet, or 16,030 acre-feet less than under No Action or LWSA.

4. Evaluation of Effects

While the magnitude of the impacts cannot be determined given the available data on groundwater irrigation relationships and because the pattern of water rights acquisitions is not known at this time, some generalizations were made. To estimate the change in the amount of water expected to recharge the shallow aquifer as a result of these water rights transfers, an estimate of the portion of the water applied as irrigation is needed. Cohen (1964) estimated that about 25 percent of the water diverted for irrigation recharges the shallow aquifer. This estimate may not be exact, but it can be used to illustrate the relative differences between alternatives on recharge of the shallow aquifer due to irrigation changes. Variability in irrigation locations, irrigated crops, water use efficiencies, soils and field layouts, and other factors make it difficult to calculate total aquifer recharge or changes in depth to water. Similarly, other factors related to land use changes, such as the reduction of natural infiltration attributable to buildings and paving, extent and efficiency of lawn and landscape watering, and storm water control projects, compound the difficulty of predicting a future change in depth to groundwater.

Depending on the location and the proximity of irrigated land conversion, some localized effects could occur. The average irrigation diversion for the period of record is 20,720 acre-feet under No Action and LWSA and 4,690 acre-feet under TROA. If the lost irrigation recharge is contiguous and localized to an area of 5180 acres, (an estimate based on diversion of 20,720 acre-feet and 4 acre-feet per acre crop demand), then the recharge loss would be 0.77 feet per acre ((16030*.25)/5180). Assuming an aquifer specific yield of 20 percent, this 0.77-foot depth change of water would result in a water table decline of 3.85 feet for the year. This is an order of magnitude type of estimate, and the number of years it would continue until new water level equilibrium would be established cannot be predicted. However, at some depth and time, a new equilibrium would be established that would balance the aquifer recharge from the remaining irrigated land, pumping and recharge operations, and the changed land uses in regards to runoff, lawn watering, precipitation, etc. Because the irrigated land area is not a contiguous block of 5,180 acres, the surrounding area would likely have a moderating influence on the underlying water table depth changes.

From another point of view, 57,170 acre-feet of irrigation water rights already have been transferred under current conditions. A total of 83,030 acre-feet of water rights are expected to be transferred under No Action and LWSA; an additional 10,520 acre-feet (93,550 acre-feet) are expected to be transferred under TROA, or 13 percent more than under the other alternatives. This difference is not expected to substantially affect local recharge of the shallow aquifer in Truckee Meadows.

5. Mitigation

No mitigation would be required because recharge of the shallow aquifer in Truckee Meadows would not be significantly affected under any of the alternatives.

E. Recharge of the Shallow Aquifer near the Truckee Canal

Recharge of the local shallow aquifer near the Truckee Canal is influenced by seepage losses from the canal. The rate of seepage losses from the Truckee Canal and the recharge of the local shallow aquifer have been investigated by others (USGS, 2000). Estimated canal seepage losses have been reported in the range of 0.8 to 4.0 cfs per mile of canal. Changes in canal seepage losses related to changes in flows in the Truckee Canal would affect recharge of the local aquifer.

1. Method of Analysis

Seepage losses are dependent upon Truckee Canal flows; therefore, this indicator was evaluated by comparing modeled average annual diversions to the Truckee Canal at Derby Diversion Dam and Truckee Canal inflow to Lahontan Reservoir, as well as Truckee Canal seepage losses calculated as a component of *total* Truckee Canal losses incorporated in the operations model. These losses are a combination of seepage, evaporation, and spills. For this analysis, these losses were assumed to contribute entirely to aquifer recharge. The actual effect of canal losses would be expected to be less than described here. Evaluation of specific aquifer effects are subjective because of the variability in aquifer geology, locations of irrigated lands, and the degree to which an irrigation water right has been used.

2. Threshold of Significance

This analysis provides a subjective assessment of the relative differences in Truckee Canal flows that could affect recharge of the shallow aquifer near the Truckee Canal. No new data were collected; significance was determined on the basis of existing reports and model outputs.

3. Model Results

Table 3.23 presents operations model results for average annual diversions to the Truckee Canal at Derby Diversion Dam, the resulting Truckee Canal inflow to Lahontan Reservoir, and Lahontan Reservoir storage and releases to the Carson Division.

Table 3.23—Parameters associated with Truckee Canal operations (in average annual acre-feet)

Parameter	Current Conditions	No Action	LWSA	TROA
Diversion to Truckee Canal (at Derby Diversion Dam)	86,400	51,810	51,670	51,780
Truckee Canal inflow to Lahontan Reservoir	52,870	43,840	43,720	43,750
Lahontan Reservoir storage (end-of-June)	231,590	225,280	225,150	224,820
Lahontan Reservoir releases	311,620	303,400	303,290	303,360

Table 3.24 presents Truckee Canal modeled losses in years of high, median, and low diversions from the Truckee River.

Table 3.24—Average annual Truckee Canal losses (acre-feet)

Diversion	Current conditions	No Action	LWSA	TROA
High	29,300	22,420	22,340	22,790
Median	12,670	3,490	3,490	3,590
Low	7,980	150	150	150

4. Evaluation of Effects

Operations model results for the parameters shown in table 3.23 differ only slightly among TROA and the other alternatives; slightly less water is provided under TROA than under No Action because senior Truckee River water rights are more able to be fully exercised to create Credit Water.

Operations model results show that, with median diversion, Truckee Canal losses are about 9,000 acre-feet per year less under each of the alternatives than under current conditions (table 3.24). Assuming that (1) all losses recharge the shallow aquifer—which is not the case due to evaporation and operational spills—and (2) losses occurs over the full length of the canal (about 32 miles total), then recharge of the shallow aquifer would be 285 acre-feet per mile less under the alternatives than under current conditions. This recharge rate would not be the same for every mile of the canal because some areas would have greater losses than others, which would create variability in the depth of the adjacent shallow aquifer. Detailed geology and localized seepage losses estimates are not available, so only generalized estimates were made. Canal seepage losses also may travel away from the canal mostly in one direction (i.e., may not travel away from the canal equally in both directions), which would double the assumed effects on the local shallow aquifer or water table.

Therefore, considering the potential shallow aquifer recharge at the canal, calculated losses, and assumed aquifer characteristics, a decline of the shallow aquifer of 3.5 to 7.0 feet was calculated at the canal at the end of one year. This loss of recharge when compared to current conditions would cause the aquifer to continue to decline until other recharge and inflows create a new dynamic equilibrium.

Relative differences in shallow aquifer recharge resulting from changes in the amount of land that would receive irrigation water can be estimated from the acreages associated with irrigation and the amount of water applied. However, variability in cropping pattern, water use efficiencies, soils and field layouts and other factors, make it difficult to estimate recharge. The deliveries of irrigation water to the lands along the Truckee Canal are expected to cease under all alternatives; that is, 18,070 acre-feet less would be diverted for the land in the future. To estimate the effect on shallow aquifer recharge, irrigation losses were assumed to be 25 percent of the diverted water and about 3,900 acres of irrigated lands were assumed to be served. USGS (1996) estimated 3,000 acres near Fernley and 900 acres in the Carson Desert were irrigated. On the basis of these assumptions, shallow aquifer recharge is about 1.2 acre-feet of water per acre of land served. Assuming that soil specific yield is 20 percent, and that the 3,900 irrigated acres are contiguous, these 1.2 acre-feet of water would require an aquifer saturation depth of 6 feet. However, this saturation depth could be affected by many other factors, including the number of wells that pump groundwater and other recharge sources. In combination with the estimated reduction in seepage losses, the shallow aquifer near the canal could decline an estimated 9.5 to 13 feet. In general terms, this is the same order of magnitude estimated by USGS (2000) in its computer model.

5. Mitigation

No mitigation would be required because no significant adverse effects would occur under any of the alternatives.

F. Groundwater Pumping in the Truckee River Basin in California

Groundwater pumping can affect the depth to water in shallow aquifers. The response of the aquifer depends, in part, on the depth and rate of pumping and the hydraulic properties of the aquifer at each well. Generally, greater pumping of the shallow aquifer lowers the water level. Conversely, continued aquifer recharge projects tend to raise the water level.

1. Method of Analysis

This indicator was evaluated by comparing average annual groundwater pumping in the Truckee River basin in California, as incorporated in the operations model, under current conditions and the alternatives.

2. Threshold of Significance

Because insufficient information is available to determine a numeric threshold significance, this analysis provides a subjective assessment of the relative differences among alternatives.

3. Model Input

As shown in table 3.25, the operations model assumed the following average annual M&I groundwater pumping in the Truckee River basin in California (in acre-feet). (See attachment D.)

Table 3.25—Average annual M&I groundwater pumping in Truckee River basin in California

Alternative	Acre-feet
Current conditions	7,573
No Action	19,600
LWSA	18,400
TROA	18,400

4. Evaluation of Effects

Average annual groundwater pumping in the Truckee River basin in California is expected to increase from 7,570 acre-feet under current conditions to 19,600 acre-feet under No Action (an increase of 12,030 acre-feet per year) to meet future demand. It is not known where this increased pumping would occur. Water budgets presented in *Groundwater Availability in the Martis Valley Groundwater Basin and Placer Counties, California* (Nimbus, 2001) show that the average annual groundwater recharge in the Martis Valley basin in California is about 34,600 acre-feet per year, at the current pumping rate of 7,570 acre-feet per year, while about 17,640 acre-feet flows out of the area. Therefore, if increased groundwater pumping were to occur in the Martis Valley basin, groundwater discharge from the area could be reduced to about 5,610 acre-feet. Despite this fairly large reduction, outflow still would occur, demonstrating the aquifer’s capacity to handle this increased pumping. Groundwater pumping under LWSA and TROA is expected to increase slightly less than under No Action (18,400 acre-feet for an increase of 10,830 acre-feet a year), so effects on groundwater recharge in the Truckee River basin in California also should be slightly less than under No Action.

Increased groundwater pumping could affect the depth to water in local shallow aquifers. Also, depending upon the location of future wells and the timing of pumping, potential effects on local streams could range from minor increases in stream losses to changing stream reaches from gaining to losing. As discussed in chapter 2, Article Ten of the Agreement provides regulations for new well construction and location. The objective of Article Ten is to minimize the effect of groundwater pumping on surface water resources by establishing setback distances from streams, rivers, and ponds. Other requirements, such as well construction and seal methods, are included to help minimize effects on the surface water resources. With the implementation of TROA, increased groundwater pumping in the Truckee River basin in California should have limited effect on streams.

5. Mitigation

No mitigation would be required because no significant adverse effects would occur under any of the alternatives.

G. Groundwater Pumping in Truckee Meadows

Groundwater is a component of the water supply for many communities, and pumping from TMWA's 33 wells (29 are located within Truckee Meadows). These wells typically provide between 15 and 20 percent of annual net water production for TMWA (TMWA, 2003). Depending upon the availability of water, many of these wells also recharge the local aquifer to store water for future withdrawal.

As discussed for the Truckee River basin in California, groundwater pumping can affect the depth to water in shallow aquifers. The response of the aquifer depends, in part, on the depth and rate of pumping and the hydraulic properties of the aquifer at each pumping site. Generally, greater pumping of the shallow aquifer lowers the water level. Conversely, continued aquifer recharge projects tend to raise the water level.

1. Method of Analysis

The operations model includes groundwater use as a part of each of the alternatives. Nevada imposes limits on the amount of groundwater that can be withdrawn based on individual water rights for each well. This indicator was evaluated by comparing average annual groundwater pumping in Truckee Meadows, as incorporated in the operations model, and the maximum allowable amount of groundwater that can be pumped per year in drought conditions under current conditions and the alternatives.

2. Threshold of Significance

Because insufficient information is available to determine a numeric threshold significance, this analysis provides a subjective assessment of the relative differences among alternatives.

3. Model Results

Table 3.26 presents modeled average annual M&I groundwater pumping and maximum annual M&I groundwater pumping in drought conditions in Truckee Meadows.

Table 3.26—M&I groundwater pumping in Truckee Meadows (acre-feet/year)

Parameter	Current conditions	No Action	LWSA	TROA
Average (operations model results)	15,350	13,310	13,590	12,810
Drought conditions (maximum limit)	22,000	22,000	26,500	15,950

4. Evaluation of Effects

As shown in table 3.26, TROA is much less reliant on groundwater pumping than the other alternatives. The operations model shows the average annual groundwater pumping is 12,810 acre-feet under TROA, compared to 13,310 and 15,350 acre-feet under No Action and current conditions, respectively. Maximum annual groundwater pumping in drought conditions under TROA is 15,950 acre-feet compared to 22,000 acre-feet under both No Action and current conditions. LWSA includes a specific component to provide for 1,000 acre-feet per year of additional recharge in normal water years to offset the greater pumping in drought conditions (26,500 acre-feet per year compared to 22,000 acre-feet per year under No Action and current conditions). Groundwater recharge is also a part of the current conditions and is expected to continue under the alternatives, as TMWA has 28 of its existing wells fitted for aquifer recharge functions. Considering the combination of pumping, recharge, and the relative degree of similarity of these alternatives, it is difficult to identify significant overall aquifer impact; however, because TROA has the lowest groundwater pumping requirements, it likely would have the least effect on future groundwater resources among the alternatives.

5. Mitigation

No mitigation would be required because no significant adverse effects would occur under any of the alternatives.

WATER QUALITY

I. Affected Environment

This section provides an overview of water quality in the study area and describes aspects of water quality that could be affected by modifying operations of Truckee River reservoirs.

Bender (1995) summarized historical Truckee River water quality data (through 1992) for the Truckee River basin from Lake Tahoe to Pyramid Lake; several data bases, which include many water quality parameters, were assessed separately. The following overview of water quality is based on data and water quality modeling for the Truckee River.

As the Truckee River flows from Lake Tahoe to Pyramid Lake, pollutants, including nutrients and total dissolved solids (TDS or organic and inorganic material in solution with water) resulting from natural erosion of the watershed and from the effects of humans, enter the river and degrade the water quality. Additionally, water is diverted for agricultural and M&I uses and is returned to the river in diminished quantity and quality. Available data did not reveal any major sources of contamination other than erosion of the watershed, agricultural runoff, and wastewater treatment plant discharges.

Metals in the Truckee River and its tributaries are not a major concern, although some concentrations are excessive on rare occasions. For example, historical data indicate that cadmium, lead, manganese, nickel, and thallium concentrations occasionally exceeded State and Federal standards. While silver and zinc concentrations were occasionally elevated in fish and invertebrate tissues, available tissue data did not reveal any excessive bioaccumulation. Naturally occurring radioactive materials are not a major concern because of low concentrations and localized occurrence.

A. Truckee River Basin: Lake Tahoe to Reno

Lake Tahoe is considered a pristine water resource. Water quality issues at Lake Tahoe are being studied and addressed by interstate agencies. Because it has been designated an Outstanding Natural Resource (ONR) under the Clean Water Act (1972 Federal Water Pollution Control Act), no man-induced degradation of Lake Tahoe's water quality is allowed. California has designated Lake Tahoe as "water of extraordinary ecological or esthetic value;" Nevada has not similarly designated Lake Tahoe.

From Lake Tahoe to Reno, the Truckee River basin is relatively pristine, with few contaminants and nutrients. Low dissolved oxygen (DO) concentration, which is harmful to fish, does not occur in this reach because of high reaeration (steep, turbulent) and low organic oxygen demand.

The primary water quality concern for the reach from Lake Tahoe to Reno is the potential for warm water temperature downstream from the discharges of TTSA and TMWR, particularly during periods of low flow. TTSA, which serves the town of Truckee and part of the community around Lake Tahoe, is located just upstream of the confluence of Martis Creek and the Truckee River. TMWRF is located just downstream from Reno. In warm weather, low flows, warm reservoir releases, and warm drainage return flows can cause the Truckee River to warm to temperatures that are detrimental to aquatic resources, including fish. For example, these conditions resulted in a fish kill downstream from the State line during the summer of 1994.

Historical data indicate that temperatures between the State line and Reno occasionally exceed acute (instantaneous exposure) and chronic (prolonged exposure) limits for trout during July and August (Bender, 1995). When Prosser Creek Reservoir or Boca Reservoir elevation is high, cool water can be released to lower the temperature in the mainstem Truckee River; however, when reservoir elevation is low, releases are warmer.

Lakes and reservoirs between Lake Tahoe and Reno appear to have no major water quality problems, although thermal stagnation due to minimal flushing and long residence time of bottom waters can result in low concentrations of DO in the bottom layers of Prosser Creek, Stampede, and Boca Reservoirs. However, bottom water aerates quickly once released, thereby increasing DO concentrations to near saturation.

B. Truckee River Basin: Reno to Pyramid Lake

From Reno to Pyramid Lake, the primary water quality concerns are warm temperatures and low DO concentrations. In warm weather, temperatures gradually increase downstream, especially in the flatter reach downstream from Reno, where flow velocities are slower. Warm temperatures and slower velocities allow algae attached to the river bottom to accumulate, increasing organic matter. Decay of organic matter, such as dead algae, can result in low concentrations of DO. (See “Exceedences of Temperature and Dissolved Oxygen Standards.”) Nutrients, which are abundant downstream from TTSA and TMWRF, help stimulate excessive algal growth in the Truckee River. Excessive algal growth downstream from Derby Diversion Dam also causes low DO concentrations.

TDS concentrations in the Truckee River also increase downstream and are a concern because Pyramid Lake is a terminal saline lake. Both temperature and salinity affect density stratification of the water layers of Pyramid Lake. Long periods of stratification lead to oxygen-deficient bottom waters, which stress cold water organisms. Below-average freshwater flows and high evaporation rates increase TDS concentrations in the surface waters of Pyramid Lake and can facilitate early turnover by increased mixing which replenishes oxygen-deficient bottom waters. Above-average freshwater inflow can dilute the salinity of surface waters so that mixing of Pyramid Lake during winter might be physically impossible due to density differences. However, a steady decline in the elevation of Pyramid Lake would also reduce the probability of mixing events.

II. Environmental Consequences

A. Introduction

Modifying operations of Truckee River reservoirs could affect lake and reservoir storage and elevations and the quantity, timing, and duration of flows. These changes could result in daily, seasonal, and annual changes in Truckee River water quality and loadings to Pyramid Lake.

This analysis evaluated the effects of changes in reservoir storage and water elevations and flows on water quality using the following indicators:

- Truckee River flows in August (irrigation month) and October (non-irrigation month) at three locations: (1) upstream of TTSA, (2) downstream from TMWRF, and (3) the inflow point to Pyramid Lake in wet, median, dry, and very dry hydrologic conditions (10-, 50-, 90-, and 95-percent exceedences).

- Annual total of days that Nevada water temperature standards are exceeded downstream from Reno. (Exceedence of standards does not imply a violation, which is an enforcement term, but rather denotes temperatures outside the range of desired criteria.)

- Annual total of days that Nevada DO standards are exceeded downstream from Reno. (Again, exceedence of standards does not imply a violation, but rather denotes DO outside the range of desired criteria.)

- TDS loadings to Pyramid Lake.

- Total nitrogen loadings to Pyramid Lake.

- Total phosphorus loadings to Pyramid Lake.

Truckee River flow is the most important indicator because it dilutes poor quality water and ties directly to reservoir operations.

TDS, nitrogen, and phosphorus (nutrient) loadings to Pyramid Lake were chosen as indicators because loadings are the output of the Dynamic Stream Simulation and Assessment Model with temperature (DSSAMt) and the input to the Pyramid Lake water quality model. Loading to Pyramid Lake is the linkage between watershed/riverine drainage modeling and the Pyramid Lake modeling.

The Truckee River transports nutrients from California to Nevada. However, interstate total maximum daily load (TMDL) issues are outside the scope of this water quality analysis. See Chapter 4, “Cumulative Effects,” for a discussion of TMDL issues.

B. Summary of Effects

Overall, under TROA, water stored in Truckee River reservoirs in wet and median years would be used to improve riverine water quality in dry years, the most critical periods for aquatic resources, including fish. In the Truckee River basin from Lake Tahoe to Reno, based on a review of historical data and best professional judgment, and when compared to appropriate California, Nevada, and Federal water quality standards, there would be no significant adverse effect on water quality under TROA. California water quality standards were used in the analysis of effects on water quality from Lake Tahoe to the State line, and Nevada water quality standards were used in the analysis of effects on water quality from the State line to Pyramid Lake. In the Truckee River basin from Reno to Pyramid Lake, under TROA, water quality standards would be met more often in representative dry years and the same or occasionally less often in representative median years than under No Action or current conditions. For example, under TROA, Truckee River TDS standards in the reaches downstream from Reno may be met less often in wet years, and more TDS may be delivered to Pyramid Lake in median years because of greater flows. However, when considering several water quality indicators, such as DO, temperature and TDS, the total water quality benefits realized in dry years under TROA would outweigh occasional adverse effects in median years and wet years. In general, greater inflow to Pyramid Lake and the resulting higher elevation and greater volume under TROA would be favorable for water quality. There are few water quality problems in representative wet years.

Table 3.27 presents Truckee River Operations Model results for average monthly (based on 100 years of record) flows in two representative months at three representative river locations in wet, median, dry, and very dry hydrologic conditions. Operations model results show that flows at the three locations are the same or nearly the same under No Action, LWSA, and TROA as under current conditions, except in dry and very dry hydrologic conditions. In dry and very dry hydrologic conditions, flows downstream from Reno and into Pyramid Lake under TROA are greater than under No Action or current conditions. In very dry hydrologic conditions, flows downstream from Reno are greater under TROA than under No Action. Under TROA, flows are adequate to dilute wastewater downstream from both TTSA and TMWRF discharge points to acceptable levels. Flows under LWSA are nearly the same as under No Action.

Table 3.28 summarizes DSSAMt results for other indicators of water quality in representative wet, median, and dry years. (See the Water Quality Appendix for definitions of representative wet, median, and dry years.) These representative years (1986—wet; 1989—median; and 1992—dry) were chosen based on recent operations rather than a long-term record. Overall, DSSAMt results show that Truckee River water quality under TROA would be better than under No Action, as shown by the number of days Nevada temperature and DO standards are exceeded downstream from Reno. These temperature and DO indicators are the most telling indicators of water quality in this reach.

Table 3.27—Truckee River average monthly flows (cfs) for selected months and reaches

Hydrologic condition	Current conditions	No Action	LWSA	TROA
August flows upstream of TTSA				
Wet	442	441	442	329
Median	110	112	112	116
Dry	68	67	66	68
Very dry	26	24	24	22
August flows downstream from TMWRF				
Wet	456	422	422	401
Median	370	339	338	360
Dry	242	288	288	323
Very dry	85	141	141	196
August flows into Pyramid Lake				
Wet	300	300	300	300
Median	200	264	265	262
Dry	109	110	110	122
Very dry	27	79	79	110
October flows upstream of TTSA				
Wet	340	347	348	309
Median	260	270	271	202
Dry	23	29	31	41
Very dry	5	12	14	21
October flows downstream from TMWRF				
Wet	683	729	729	651
Median	434	460	460	452
Dry	182	180	177	207
Very dry	63	79	79	114
October flows into Pyramid Lake				
Wet	674	711	710	631
Median	396	429	429	432
Dry	100	109	109	104
Very dry	25	35	35	56

Table 3.28—Summary of modeled exceedences of Nevada temperature (T) and DO standards

Representative year	Current conditions	No Action	LWSA	TROA
Days T standards exceeded Lockwood-Derby				
Wet	32	32	32	29
Median	28	32	27	28
Dry	85	120	119	87
Days DO standards exceeded Lockwood-Derby				
Wet	0	0	0	0
Median	0	0	0	0
Dry	109	42	39	3

Table 3.29 summarizes DSSAMt results for TDS, total nitrogen, and total phosphorus loadings to Pyramid Lake. These mass loadings were derived by multiplying concentration by flow. Results show that, under TROA, loadings to Pyramid Lake are greater than under No Action or current conditions in representative median and dry years. Results also show greater differences in water quality *among* representative wet, median, and dry years than between No Action and TROA. As shown in table 3.29, the majority of loading to Pyramid Lake occurs in representative wet years; however, the cumulative loadings (i.e., total combined loadings in representative wet, median, and dry years) to Pyramid Lake themselves differ little (less than 10 percent) between the alternatives and current conditions. Greater loading indicates that, cumulatively, more flow would reach Pyramid Lake under TROA.

Table 3.29—Summary of loadings to Pyramid Lake

Representative year	Current conditions	No Action	LWSA	TROA
TDS loading to Pyramid Lake (100,000 kilograms)				
Wet	1,243	1,238	1,237	1,222
Median	355	346	345	353
Dry	143	119	120	177
Total nitrogen loading to Pyramid Lake (1,000 kilograms)				
Wet	358	368	365	344
Median	65	67	67	70
Dry	12	11	11	20
Total phosphorus loading to Pyramid Lake (1,000 kilograms)				
Wet	40	41	41	39
Median	7	7	7	7
Dry	1.6	1.4	1.4	3.1

Under TROA, water stored in wet and median years would be used during warm periods in dry years, the times with the greatest water quality concerns. Therefore, water quality typically would be better under TROA in representative dry years than under No Action or current conditions.

Tables 3.27, 3.28, and 3.29 summarize a large amount of information for purposes of comparing alternatives. Detailed modeling information for all locations and reaches, for shorter periods of time, for wet, median, and dry hydrologic conditions, and for many water quality constituents are provided by Brock and Caupp (2004a-h) in two volumes for each alternative. The Water Quality Appendix provides additional information, including summary tables of the water quality simulations (DSSAMt tables 1 through 12) and fish water temperature simulations (DSSAMt tables 13 through 24).

C. Overview of Methods of Analysis

Two methods were used to analyze water quality: (1) a historical data analysis of the entire Truckee River system, and (2) a computer modeling analysis (DSSAMt) of the Truckee River from just downstream from the California-Nevada State line to Pyramid Lake**.** The historical data analysis was used to identify water quality concerns throughout the Truckee River basin. Historical data were compared to appropriate California, Nevada, and Federal water quality standards; the following section summarizes water quality standards for both California and Nevada waters affected by TROA. Because DSSAMt addresses water quality downstream from the California-Nevada State line (i.e., in Nevada), it was used to quantitatively compare riverine water quality under current conditions and the alternatives only to Nevada water quality standards. The reach from Reno to Derby Diversion Dam, the flatter river reach, has marginal or degraded water quality and was the focus of the modeling, as discussed further in this section. Brock et al. (2004) provide a complete model formulation and program description. Brock and Caupp (1997, 1998a, 1998b) also provide a complete description of water quality standards and model calibration, verification, performance, input sensitivity, and simulated river temperatures and water quality. The Water Quality Appendix references these documents and also includes summary statistics for DSSAMt calibration and verification.

Upstream and tributary flows and DSSAMt input boundary conditions were derived from Watershed Analysis Risk Management Framework (WARMF) model output. To correspond with flows and operations used for current conditions, flow inputs for the WARMF model were developed from operations model output, while land use changes were used to predict changes in nonpoint sources. Land use from 1999 was used for current conditions, and predicted land use in 2020 was used for the alternatives.

The effect of biological nitrogen removal (BNR) at TTSA was modeled for both current conditions and the alternatives. BNR is environmentally superior to the previous anion exchange technology and has the ability to minimize TDS and chloride increases in the Truckee River while achieving target nitrogen concentrations. These upgrades will greatly reduce the salt loads reaching Nevada and, ultimately, Pyramid Lake. However, nitrate loadings from TTSA would increase by the year 2033 because of a projected maximum 7-day average municipal wastewater flow increase under current conditions of 7.4 million gallons per day to 9.6 million gallons per day under the alternatives. (Also, see “Total Dissolved Solids and Nutrient Loadings to Pyramid Lake.”)

Point source loadings for TMWRF were derived for current and a realistic future wastewater treatment process. Because of increases in population or development and corresponding increases in wastewater discharges with the existing wastewater treatment plant operations and future streamflows, the modeled TMWRF total nitrogen mass loadings were consistently projected to exceed permitted values. A major component of the total nitrogen is organic nitrogen, which is not readily bioavailable and likely does not substantially add to algal biomass or result in low DO. Therefore, model results show that “total” nitrogen standards are exceeded frequently; however, DO standards are exceeded infrequently, especially under TROA.

The analysis assumed that cities and counties will attempt to meet future Truckee River water quality objectives by constructing additional treatment facilities, providing additional dilution water, or by spreading wastewater over agricultural lands with makeup water provided to the Truckee River. TMWRF managers have recognized the total nitrogen and organic nitrogen issues and are studying cost-effective approaches. DSSAMt assumed that State and local governments would implement sufficient mechanisms as populations grow to treat wastewater and limit urban runoff to maintain adequate riverine water quality, including storm water best management practices and total maximum daily loads. Under section 303(d) of the Clean Water Act, States, territories and authorized tribes are required to develop a list of water quality limited segments. Waters on the “303(d) list” are considered impaired, i.e., they do not meet water quality standards, even after installation of the minimum required levels of pollution controls. The law requires that these jurisdictions establish priority rankings for waters on the 303(d) lists and develop action plans, called TMDLs, to improve water quality.

Nevada’s 303(d) list of impaired water bodies includes the Truckee River reach from Reno (East McCarran Boulevard) to Derby Diversion Dam. Existing TMDLs for total nitrogen, total phosphorus, and TDS were established in 1993 at Lockwood, which is downstream from discharges from TMWRF. This study emphasized evaluation of water quality in the Lockwood to Derby Diversion Dam reach. Temperature and DO in the Lockwood to Derby Diversion Dam reach are the most important indicators of water quality in this critical reach. Also see “Sedimentation and Erosion.”

DSSAMt simulates hourly changes in 26 water quality parameters for 105 subreaches of the Truckee River. Automated plots and tables of summarized information were generated for analysis. Results include data on all indicators of water quality except Truckee River flows.

Inputs to DSSAMt included flows generated from the operations model, actual meteorological data, actual water quality data, initial and boundary water quality conditions derived from WARMF, and Nevada water quality standards and preferred temperatures. Flows generated from the operations model and actual air temperature data were used to predict water temperature and DO concentrations and loadings to Pyramid Lake.

Truckee River flows were generated from the operations model for wet, median, dry, and very dry hydrologic conditions in representative months at representative locations.

These indicators and the methods of analysis are appropriate for assessing potentially significant effects on water quality. However, no certain correlation exists between the indicators and all other water quality constituents. Therefore, 9 years of data were used to calibrate and verify the temperature and water quality components of DSSAMt to reduce the uncertainty of analysis.

D. Summary of Pertinent Water Quality Standards for California Waters

The term “water quality standards” is defined in regulations that implement the Clean Water Act:

> Water quality standards are provisions of State or Federal law which consist of a designated use or uses for the waters of the United States and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water, and serve the purposes of the act (40 Code of Federal Regulations [CFR] 130.2(d) and 131.3(i)).

Thus, water quality standards must contain at least two critical components: (1) the designation of beneficial uses of water (contained in the Water Quality Appendix) and (2) the establishment of water quality criteria designed to protect those uses.

In California, the Water Quality Control Plans contain the State’s water quality standards because these plans set forth beneficial uses of water of the State and water quality objectives (the “criteria” under the Clean Water Act) to protect those uses. One critical difference between the State and Federal programs is that while the Clean Water Act focuses on surface water resources, the term “waters of the state” under the Porter-Cologne Act includes both surface water and groundwater. Therefore, California has water quality standards applicable to groundwater as well as to surface water. The Porter-Cologne Water Quality Control Act is found in Division 7 of the California Water Code.

California's water quality standards include designated beneficial uses and narrative and numerical water quality objectives. Twelve different beneficial uses apply to Lake Tahoe, and fourteen apply to the Truckee River; a similar variety of uses has been designated for tributary waters. In particular, all surface waters of these basins are designated for municipal and domestic supply (MUN) use, and all lakes and streams of the Truckee River basin are designated for “Rare, Threatened, or Endangered Species” use in recognition of the proposed reintroduction of the LCT to its original range. Beneficial uses would not change under the alternatives. Beneficial uses of surface water in the California portion of the study area (Lake Tahoe, Little Truckee, and Truckee River basins) include the following:

- Municipal and domestic supply
- Agricultural supply
- Ground water recharge
- Freshwater replenishment
- Water contact and non-contact recreation
- Cold freshwater habitat
- Wildlife habitat
- Hydroelectric power generation (Truckee River and Little Truckee River basins only)
- Rare, threatened, or endangered species
- Migration of aquatic organisms
- Spawning, reproduction, and development
- Water quality enhancement
- Flood peak attenuation/flood water storage
- Industrial service supply (Truckee River basin only)
- Navigation (Lake Tahoe and Truckee River basins only)
- Commercial and sportfishing (Little Truckee River and Truckee River basins only)
- Preservation of biological habitats of special significance (Lake Tahoe basin only)

Beneficial uses of groundwater in California include the following:

- Municipal and domestic supply
- Agricultural supply
- Industrial service supply

Applicable water quality objectives include region-wide objectives for parameters such as un-ionized ammonia, dissolved oxygen, taste and odor, pH, and pesticides. State drinking water maximum contaminant levels for chemical constituents (including "priority pollutants") and radioactivity apply to all waters designated MUN.

Waterbody-specific objectives have been adopted for constituents such as nutrients, TDS, and chloride. Most of these objectives have been set at monitored or modeled historic natural background levels, which generally reflect much higher quality than that needed to protect MUN use. The aquatic life uses of the Lake Tahoe and Truckee River basins reflect oligotrophic (low productivity) or nutrient poor conditions, and stringent nutrient objectives are needed to prevent eutrophication or nutrient rich conditions. Objectives for Lake Tahoe include the clarity and phytoplankton primary productivity levels measured between 1968 and 1971. Revised wastewater discharge requirements for the Truckee River downstream from TTSA leach fields are mass loading limitations and reflect effects of natural background quality. While less-than-natural quality is allowed downstream from TTSA as a result of findings under the State nondegradation policy in 1980, TTSA will evaluate nitrogen removal if objectionable levels of periphyton (attached algae) occur in this reach in the future.

The Lahontan Basin Plan includes a regionwide narrative nondegradation objective which implements California State Water Resources Control Board (SWRCB) Resolution 68-16. This resolution provides that the quality of high-quality waters cannot be lowered unless findings are made that the degradation is of maximum benefit to the people of the State and that it will not reasonably affect present and anticipated beneficial uses. If degradation is permitted, quality cannot be lowered to less than levels required by water quality standards. The basin plan also includes a separate regionwide nondegradation objective for wetland communities and populations, which, among other things, provides, "All wetlands shall be free from activities that would substantially impair the biological community as it naturally occurs due to physical, chemical, and hydrologic processes."

For stream segments and water bodies that are not listed under section 303(d) (total maximum daily loads and individual water quality-based effluent limitations) of the Clean Water Act, Federal antidegradation regulations provide that where lowering of water quality is permitted in exchange for socioeconomic benefits, beneficial uses must still be fully protected.

California water quality goals were used to identify potential water quality issues in the reaches of the Truckee River and tributaries located in California. Recent California water quality goals are summarized by Marshack (2003).

E. Summary of Pertinent Water Quality Standards for Nevada Waters

The Nevada Administrative Code (NAC), Chapter 445A.118-445A.225 contains the State's water quality standards. NAC contains two types of water quality standards, narrative and numeric. The narrative standards are applicable to all surface waters of the state and consist mostly of statements requiring water to be "free from" various pollutants including those that are toxic. The numeric standards for conventional pollutants are broken down into two types: class and water body specific. For the class waters, criteria for various pollutants are designed to protect the beneficial uses of classes of water, from A to D; with class A being the highest quality. The water bodies belonging to these classes are named in the regulations.

For major water bodies in Nevada, site-specific numeric standards have been developed. These standards include both criteria designed to protect the beneficial uses and antidegradation requirements. The antidegradation is addressed through the establishment of "requirements to maintain existing higher quality" (RMHQ). RMHQs are set when existing water quality (as evidenced by the monitoring data) for individual parameters is higher than the criteria necessary to protect the beneficial uses. This system of directly linking antidegradation to water quality standards provides a manageable means for implementing antidegradation through the permit program and other programs. The Truckee River has site-specific standards, and these were incorporated into DSSAMt (Nevada, 2004).

Beneficial uses in the Lake Tahoe and Truckee and Carson River basins in Nevada include the following: irrigation; watering of livestock; contact and non-contact recreation; industrial supply; municipal and/or domestic supply; propagation of wildlife; propagation of aquatic life; enhancement of water quality (Lake Tahoe basin only); and water of extraordinary ecological or aesthetic value (Lake Tahoe basin only). Nevada State standards do not apply to Tribal lands.

F. Truckee River Flows

The most important indicator of Truckee River water quality is flow, which affects all aspects of water quality, including dilution of water reclamation facility discharges. Low flows result in warming of the river and in stagnant water, while high flows flush nutrients, organics, sediments, and poor quality water downstream.

1. Method of Analysis

Flows vary according to time of year, river location, and hydrologic condition. Flows (generated from the operations model) were compared in two representative months at three representative river locations in wet, median, dry, and very dry hydrologic conditions (10-, 50-, 90-, and 95-percent exceedences).

August was selected as the low-flow irrigation month and October as the low-flow non-irrigation month. Three river locations were evaluated: (1) upstream of TTSA, (2) downstream from TMWRF, and (3) the inflow point to Pyramid Lake. The first location incorporates the dilution downstream from the water reclamation facility in California. The second location incorporates the dilution just downstream from the major metropolitan Reno/Sparks area with warm temperatures and the reach with a DO "sag" due to decaying organics and algal growth from nutrients. Loadings to Pyramid Lake were calculated at the inflow point.

2. Threshold of Significance

In general, a 10-percent or greater difference in flows between the alternatives and current conditions or between the action alternatives and No Action was considered significant. The combination of errors in factors such as instrumentation, flow data collection, data processing, and computation have a 5- to 10-percent margin of error. However, relative differences among model results are more accurate and have less than a 5-percent margin of error.

3. Model Results

Table 3.27 presents operations model results for August and October flows at the three locations in wet, median, dry, and very dry hydrologic conditions.

4. Evaluation of Effects

a. No Action

Operations model results show that, under No Action, flows at the three locations are similar or greater than under current conditions, except upstream of TTSA in August in very dry hydrologic conditions, when flows may be 8 percent less (24 cfs compared to 26 cfs). This difference is insignificant because it is within the margin of error of the model results.

Under No Action, flows downstream from TTSA should be sufficient during October in very dry hydrologic conditions to prevent poor water quality in California.

b. LWSA

Overall, water quality under LWSA would be about the same as under No Action and better than under current conditions, as shown by flow statistics. Greater flows than under current conditions would provide greater dilution of pollutants and increased habitat for biota.

c. TROA

Overall, operations model results show that water quality under TROA would be better than under No Action or current conditions because flows are greater and flow timing is more favorable. For example, flows downstream from TTSA in October in very dry hydrologic conditions are 21 cfs under TROA compared to 12 cfs under No Action, thereby providing additional dilution water for wastewater discharges. Also, TROA would provide the flexibility to rapidly flush the river to improve water quality.

G. Compliance with Nevada Water Temperature and Dissolved Oxygen Standards

Truckee River water temperature is an important indicator of river water quality because it directly affects fish reproduction, growth, and survival. Warmer temperatures may stimulate production of biota, including algae, and decrease concentrations of DO, another important indicator of water quality. Extremely warm temperatures are detrimental to fish and biota.

Dissolved oxygen is required for respiration by aerobic life forms, such as fish, and for decay of organic matter, such as dead algae. Because the rate of biochemical reactions that use oxygen increases with increasing temperature, low DO concentrations in the Truckee River tend to be more critical in warm summer months. The problem is compounded in the summer because flows are usually less and DO saturation is less at higher temperatures. Therefore, the total possible quantity of oxygen available in the water is also less.

1. Method of Analysis

Truckee River water temperature and DO concentrations vary according to reach and calendar year. Therefore, temperature and DO concentrations for the Truckee River reach from Lockwood to Derby Diversion Dam (generated from DSSAMt) were evaluated. This reach is downstream from two major tributaries, North Truckee Drain and Steamboat Creek, which contribute urban runoff and return flows from TMWRF. Lockwood is downstream from Reno (map 3.1), a major source of pollutants and organics, and in this reach, water quality constituents are completely mixed from bank to bank.

2. Threshold of Significance

An effect was considered significant if Nevada standards were exceeded 5 days or more annually. Exceedence of a standard for as little as 1 hour was counted as 1 day, even though biota, in general, can tolerate poor water quality for such a brief period.

3. Model Results

Table 3.28 presents DSSAMt results for the annual total days that Nevada temperature and DO standards are exceeded in this reach in representative wet, median, and dry years.

4. Evaluation of Effects

a. No Action

DSSAMt results show that Nevada temperature standards are exceeded significantly in this reach in representative dry years under current conditions and No Action, although temperature standards under No Action are exceeded more often than under current conditions. Temperature standards also are exceeded in representative wet and median years under current conditions and No Action.

DSSAMt results also show that Nevada DO standards are exceeded significantly in this reach in representative dry years under current conditions and No Action. DO standards are exceeded infrequently in representative wet and median years. DO standards under No Action are exceeded less often than under current conditions, although low DO occurs in representative median and dry years under current conditions and No Action. (See Water Quality Appendix DSSAMt tables 1 through 12.)

b. LWSA

DSSAMt results show that water quality under LWSA is about the same as under No Action and better than under current conditions, as indicated by the number of days that Nevada temperature and DO standards are exceeded (table 3.28). In representative dry years, water temperatures are slightly cooler and DO concentrations under LWSA are slightly greater than under No Action. However, compared to current conditions, temperatures in representative dry years are warmer and standards are met less often.

c. TROA

Overall, DSSAMt results show that, under TROA, Truckee River water quality is “significantly” better than under No Action or current conditions, as shown by the number of days that Nevada State temperature and DO standards are exceeded (table 3.28), especially in representative dry years.

In representative dry years, under TROA, temperatures downstream from Reno are cooler and DO concentrations are greater than under No Action. In representative dry years, the greater flows push nutrients downstream quickly. As a result, standards are met more often. DSSAMt results show that, under TROA, Nevada State temperature standards are exceeded about as often in representative dry years as under current conditions.

DO standards are met more often in representative dry years under both TROA and No Action than under current conditions. As under No Action and LWSA, DO standards downstream from Reno are met more often under TROA than under current conditions, which is likely partly due to implementation of WQSA. However, under TROA, DO standards are almost never exceeded downstream from Reno in representative dry years, partially because WQSA would be enhanced under TROA. Therefore, in representative dry years, DO and overall water quality under TROA would be “significantly” better than under No Action or current conditions in most reaches of the Truckee River downstream from Reno.

H. Total Dissolved Solids and Nutrient Loadings to Pyramid Lake

Total dissolved solid, total nitrogen, and total phosphorus loadings to Pyramid Lake are indicators of Pyramid Lake water quality and indirect indicators of Truckee River quality.

Overall, DSSAMt results show that, under TROA, greater flow and, therefore, slightly more TDS, reaches Pyramid Lake. Therefore, the elevation of Pyramid Lake is higher and, thus, its volume is greater than under No Action or current conditions. Total nitrogen and phosphorus loadings under TROA are about the same as under No Action or current conditions.

In general, most loadings to Pyramid Lake occur during large runoff events in representative wet years. In these years, concentrations are typically low and Nevada standards are not exceeded often. In representative dry years, loadings to Pyramid Lake are minimal, but standards in the lower Truckee River are exceeded frequently under both current conditions and the alternatives because of low Truckee River flows and large diversions.

Total dissolved solids concentrations generally increase downstream and are an overall indicator of water quality degradation due to repeated water use. Likewise, the maximum TDS standards for river reaches increase downstream. Therefore, TDS standards are sometimes exceeded more frequently just downstream from where high TDS loadings from Steamboat Creek, North Truckee Drain, Helms Gravel Pit, and TMWRF discharge into the Truckee River. During low flows, TDS in the Truckee River downstream from Derby Diversion Dam frequently exceeds Nevada standards. High inflows contribute high TDS loadings to Pyramid Lake. Low flows, evaporation, and groundwater inflows with high concentrations result in high TDS concentrations in the lower Truckee River. Greater inflows of relatively fresh water to Pyramid Lake decrease TDS by dilution. Evaporation and less inflows to Pyramid Lake tends to increase TDS.

The concerns of the Pyramid Tribe about compliance with the TDS standard have been relieved primarily due to recently installed BNR technology at TTSA, which replaced anion exchange technology. Anion exchange added total dissolved solids (salts) to the Truckee River. BNR does not add TDS and ultimately reduces the TDS concentrations discharged to Pyramid Lake, thereby addressing the Tribe’s concerns. BNR was modeled for both current conditions and the alternatives. However, the loading from TTSA is comparably smaller than the loading from TMWRF and the Reno-Sparks metropolitan nonpoint sources.

Nutrients, such as nitrogen and phosphorus, are essential to the growth of algae and other plants and organisms in the Truckee River and Pyramid Lake. Thus, large nutrient loadings can stimulate excess algal growth and, consequently, organic matter decay. A majority of the total nitrogen reaching Pyramid Lake is organic nitrogen, which is not readily bioavailable for attached algae in the Truckee River. Once the organic nitrogen reaches Pyramid Lake, it has time to decay and can be used by green algae. Blue-green algae can produce excessive mats and reduce DO by respiration. At low nitrogen levels, blue-green algae can fix atmospheric nitrogen and grow more efficiently than the green algae, which become nitrogen-limited during summer and fall. Overall, more algal biomass due to more nutrient loading causes more decayable matter and less DO at the sediment water interface. The annual Pyramid Lake water quality model was run to determine if loading differences have a significant impact on Pyramid Lake water quality. Results of this model show little difference in Pyramid Lake water quality between the action alternatives and No Action or between any of the alternatives and current conditions.

1. Method of Analysis

The WARMF model used current and projected future land use to determine loadings from point and nonpoint sources. Output from the WARMF model was used as input to DSSAMt. TDS, total phosphorus, and total nitrogen loadings at the mouth of the Truckee River were used as water quality indicators and as partial input to the Pyramid Lake water quality model.

2. Threshold of Significance

In general, a 10-percent or greater difference in combined loadings between the alternatives and current conditions or between the action alternatives and No Action was considered significant. Model results have a 5- to 10-percent margin of error largely due to flow measurement errors of about 5 to 10 percent.

3. Model Results

Table 3.29 presents DSSAMt results for annual total TDS, total nitrogen, and total phosphorus loadings to Pyramid Lake in representative wet, median, and dry years.

4. Evaluation of Effects

a. No Action

Overall, DSSAMt model results show that Pyramid Lake water quality under No Action would be the same or slightly better than under current conditions. Specifically, under No Action, water quality may be the same in representative wet and median years and slightly better in representative dry years than under current conditions, as shown by TDS, total nitrogen, and total phosphorus loadings to Pyramid Lake. Slightly less TDS would be transported to Pyramid Lake under No Action in representative median and dry years.

b. LWSA

Loadings to Pyramid Lake under LWSA are about the same under No Action. Therefore, the effects on Pyramid Lake water quality also are expected to be about the same.

c. TROA

Overall, in representative wet years, Pyramid Lake water quality under TROA would be the same as or better than under No Action, as shown by TDS, total nitrogen, and total phosphorus loadings to Pyramid Lake. In representative median and dry years, operations model results show that, under TROA, flows to Pyramid Lake are greater than under No Action, resulting in slightly greater TDS loading to Pyramid Lake. However, the benefits of the greater flows and a higher Pyramid Lake elevation would outweigh the adverse effects of greater TDS. Loadings under TROA are similar to those under current conditions.

5. Mitigation

No mitigation for water quality would be required because no significant adverse effects would occur under TROA.

SEDIMENTATION AND EROSION

I. Affected Environment

This section describes those aspects of sedimentation and erosion in the study area that could be affected by modifying operations of Truckee River reservoirs or that are of interest to the public or private agencies. Specifically, this section discusses shoreline erosion at Lake Tahoe, stream channel erosion and sediment transport in the Truckee River, and Truckee River delta formation at Pyramid Lake.

A. Shoreline Erosion at Lake Tahoe

As stated previously in "Water Quality," Lake Tahoe has been designated as an ONR under the Clean Water Act and, as such, no man-induced degradation of its water quality is allowed. Under the Clean Water Act, Lake Tahoe is "303(d)-listed" because of loss of clarity (or transparency) due to excessive nitrogen, phosphorus, and sedimentation/siltation. These parameters were investigated to identify total maximum daily loads to Lake Tahoe for each. SWRCB also adopted Resolution 68-16, which establishes a nondegradation policy for the protection of water quality, where waters are designated as high quality water, including Lake Tahoe (SWRCB, 1994). It is considered an oligotrophic (low productivity) lake; that is, it still has relatively low concentrations of nitrogen and phosphorus.

Suspended sediment directly and indirectly affects Lake Tahoe water quality because the sediments carry nutrients into the lake. Reuter and Miller (2000) found that approximately 450 to 900 metric tons of sediment are introduced to the lake each year. Adams (2003) documented historic shoreline erosion using geographic information system (GIS) analysis. The total surface area of the eroded shoreline was estimated to be 32,000 square meters, or 429,000 metric tons, eroded between 1938 and 1998, an average of about 7,150 metric tons per year. This estimate of historical shoreline erosion is far more accurate than the amount predicted by Reuter and Miller (2000), because it was based on measurements of shoreline erosion from repeat aerial photography rather than a reasonable guess of the potential erosion rates.

Shoreline erosion is a result of many factors, including wave action, material properties of the shoreline, climate, and fluctuating water elevation. More specifically, shoreline erosion is typically caused by waves breaking at the base of easily eroded bluffs when the water elevation is high. Both the direct impact of waves on the bluffs and the onrush of waves up the beach are capable of erosion and sediment transport. When the water elevation is low, wave energy is expended on the beach and long-term shoreline erosion is reduced. (See the Sedimentation and Erosion Appendix for a detailed discussion.)

1. Wave Action

The main mechanism of shoreline erosion is wave action caused by winds. Wave action is most damaging when (1) waves are high, (2) the water is high, i.e., between elevations 6227.0 and 6229.1 feet, the maximum managed elevation, (3) nearshore slope is steep, and (4) shoreline sediments are unconsolidated.

Another factor that affects wave action is runup, defined as the rush of water up a slope due to the breaking of a wave. Runup varies directly with wave height and inversely with foreshore slope. For gentle slopes, runup is greater because water moves further up the shore, reaching materials that otherwise would be undisturbed. The slope of the offshore lake bottom also affects wave action. The gentler the slope, the sooner the wave intersects the lake bottom, and the farther from shore the wave will break. In that case, wave energy is dissipated further from shore and has less effect on backshore erosion.

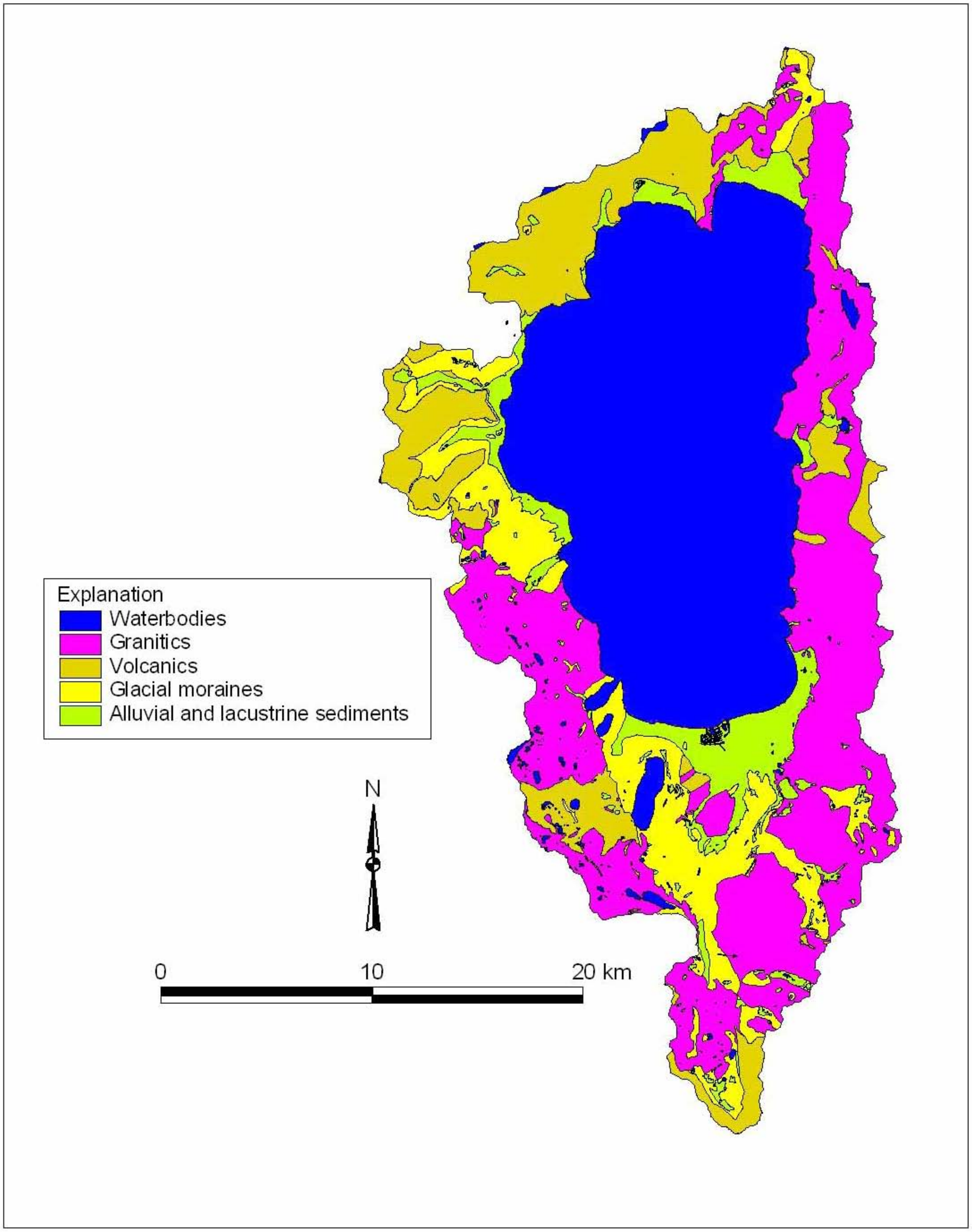
2. Material Properties of Shoreline

The eastern shore of Lake Tahoe contains granitic bedrock. The south shore consists mainly of glacial outwash, and the west shore is predominantly glacial moraines, outwash and lake deposits, although granitic bedrock is found at Rubicon Point. The north shore is comprised of volcanic rocks with some granites and many areas of alluvial and lake deposits. Thus, the south, west, and north shores are erodible (map 3.3).

Orme (1972) thought that 16 percent of the Lake Tahoe shoreline is eroding. Osborne et al. (1985) concluded that (1) the principal sediment source of the major sand beaches at Lake Tahoe is the backshore erosion of lake and glacial outwash and (2) the major sediment source for the gravel and cobble is also erosion of the backshore areas and possibly nearshore erosion of lakebed deposits, moraines, and volcanic rocks. Sand is delivered to smaller beaches by weathering of granite bedrock and boulders.

Unconsolidated sediments that may contribute to lake degradation have three predominant sources: (1) foreshore, (2) backshore, and (3) nearshore. Foreshore is the zone of lake elevation fluctuation, or the area between high and low water surface elevations. At Lake Tahoe, the zone of fluctuation is between elevation 6229.1 and 6223.0 feet (a height of 6.1 feet). Backshore, where the water meets the land, is the zone of instability. The lakeward limit of the backshore is the high water elevation. Nearshore is the zone that extends from the low water elevation of 6223.0 feet down 30 feet to a lake bed elevation of 6193.0 feet (TRPA, 1995).

Unconsolidated sediments (of which sand and finer grained particles are the most easily transported) in the foreshore and nearshore can become entrained because of wave action. These sediments either can be deposited on the shore or can drift out into the lake. Such movement of sediments into the lake is not considered in the evaluation. Sediment in the foreshore is continually exposed to wave action in the normal operating range of Lake



Map 3.3—Generalized geology map of Lake Tahoe (Adams, 2003).

Tahoe (elevation 6223.0 to 6229.1 feet). That is, sediment continually moves back and forth between the lake and the shore at all lake elevations. These movements are the same regardless of operations (Adams, 2003).

Sediments from the backshore could erode and move into the lake if its elevation were comparatively higher. Such erosion could be possible when the elevation of the lake is between 6227 and 6229.1 feet. The greatest potential for erosion events occurs when strong winds blow across the lake and the lake water elevation is at maximum (Adams, 2001). At such high elevations, more unconsolidated sediments are accessible to wave erosion within the backshore. At lower elevations, finer, smaller sediments have already been eroded from the shore surface, leaving gravels, cobbles, and bedrock as armor against additional erosion.

3. Climate

The climate of the Lake Tahoe basin is also important to shoreline erosion. The lake is generally higher during the late winter, spring, and summer. Erosion of the lake occurs more frequently when the elevation is 6627 feet or higher and when strong winds blow across the lake, usually during late winter or spring.

4. Fluctuating Water Elevation

Another important factor to shoreline erosion at Lake Tahoe is seiche, which is a periodic oscillation of the water body. Seiches can temporarily raise water elevation along a shore, allowing waves to go further inland. LeConte (1884) estimated that the period of a seiche at Lake Tahoe is 17 minutes in a north-south direction and 10 minutes in an east-west direction.

B. Stream Channel Erosion and Sediment Transport

Stream channel erosion occurs along some reaches of steams in the Truckee River basin, although most streams in the basin are well armored and experience little erosion. Background data on normalized average annual sediment loads in the Truckee River are presented in figure 3.35 for several sub-watersheds. The basins with the highest annual suspended sediment load include Bear, Squaw, Donner, and Gray Creek watersheds. These watersheds show high rates of suspended sediment load either because of rapid urbanization or naturally occurring high erosion rates, as in Gray Creek.

As discussed in “Water Quality,” under section 303(d) of the Clean Water Act, States, territories and authorized tribes are required to develop a list of water quality limited segments. Waters on the 303(d) list are considered impaired, i.e., they do not meet water quality standards, even after installation of the minimum required levels of pollution controls. The law requires that these jurisdictions establish priority rankings for water on the lists and develop action plans, called TMDLs, to improve water quality. Waters within the study area that are listed as impaired on the 303(d) list are presented in table 3.30.

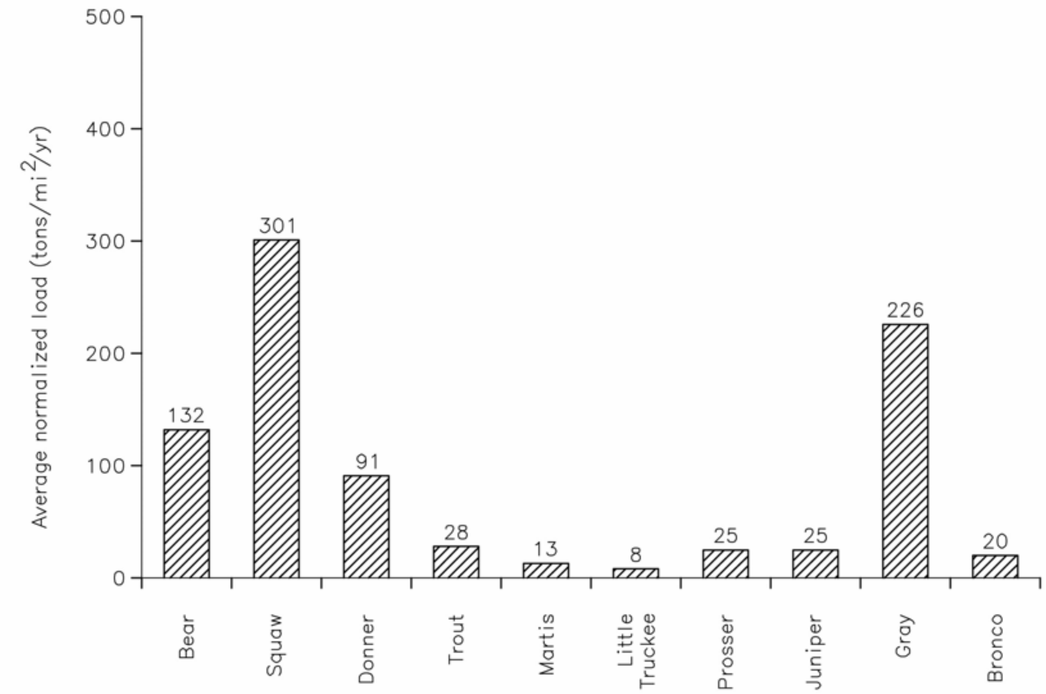


Figure 3.35—Average annual suspended sediment load normalized by area (McGraw et al., 2002).

Table 3.30—Section 303(d) list of impaired waters within study area

Name	Pollutants/stressor	TMDL priority	Extent affected
Bear Creek	Sedimentation/siltation	Medium	3 miles
Bronco Creek	Sedimentation/siltation	Medium	1.3 miles
Donner Lake	Priority Organics	Low	819 acres
Gray Creek	Sedimentation/siltation	Medium	2.8 miles
Heavenly Valley Creek (source to USFS boundary)	Chloride	Low	2 miles
	Phosphorus	Low	2 miles
Heavenly Valley Creek (USFS boundary to Trout Creek)	Chloride	Low	1.4 miles
	Sedimentation/siltation	Low	1.4 miles
Squaw Creek	Sedimentation/siltation	Medium	5.8 miles

The Upper Truckee River is the largest stream tributary to Lake Tahoe in terms of flow and watershed size, and it may deliver some of the largest nutrient and sediment loads to the lake. The watershed was severely disturbed in the 19th and early 20th centuries by logging and grazing, and in the later 20th century by urban development. The Upper

Truckee River is currently identified as impaired under section 303(d) (table 3.30). The Lake Tahoe Watershed Assessment gave the river an Aquatic Ecosystem Rating of “imperiled” (SWRCB, 2002).

The Trout Creek watershed, located east of the Upper Truckee River, has been disturbed by historic logging and livestock grazing, ski resort development (Heavenly Valley), and urban development (near Lake Tahoe). Trout Creek and its tributary Heavenly Valley Creek, Ward Creek and Squaw Creek are all 303(d)-listed.

The Truckee River from Lake Tahoe to the Nevada State line and some of its tributaries are considered impaired for sediments. Two watersheds with highly erosive drainages are also considered impaired: Bronco Creek and Gray Creek. Donner Lake is also considered impaired for organics under section 303(d) of the Clean Water Act. Additional information is presented in Chapter 4, “Cumulative Effects.” The creeks are underlain by large areas of volcaniclastic rocks and are considered to be highly erosive. These watersheds also have steep valley side slopes and large gradients in the lower part of each watershed, which also make these watersheds very erosive (McGraw et al., 2001).

The potential for erosion in the Truckee River basin is based on the combined effects of precipitation, slopes, and soil types. Soils on 0- to 5-percent slopes are at the southern end of Lake Tahoe, in Martis Valley in the Little Truckee River basin, and in Truckee Meadows. These soils areas are glacial and alluvial outwash and represent 8 percent of the Truckee River basin area upstream of Reno.

Approximately 15 percent of the Truckee River basin area is located on 5- to15-percent slopes on glacial outwash and terraces and alluvial fans. These soils have moderate erosion. Areas with 15- to 30-percent slopes, which make up 15 percent of the watershed—primarily in the Little Truckee, Prosser and Donner Creek basins—are primarily mountain slopes, moraines, and upland ridges. These soils have moderate erosion. On 30- to 50-percent slopes, which comprise 42 percent of the Upper Truckee River basin area, are mountain slopes and outwash moraine. These soils have moderate erosion. About 2.5 percent of the area is on slopes greater than 50 percent, which are canyon side slopes in headwaters of Donner Creek and along the Truckee River canyon north of Farad. These soils have high to severe erosion.

The potential for erosion is greatest in the Truckee River canyon. The highest sediment yield areas of the basin are the Gray Creek watershed and the upper portion of Bronco Creek. The second highest sediment yield area of the watershed is Dog Valley and the contiguous mountain slopes to the east. Erosion also occurs in Washoe County but is not a major problem. Soils in Truckee Meadows are susceptible to erosion and can erode quickly when they are subject to heavy water flow. Occasional landslides occur along the Truckee River and have developed on slopes near Mogul, probably because of river erosion (Westpac Utilities, 1990). High turbidity, an indication of erosion, has been observed in Bronco Creek and Gray Creek during storms; these tributaries enter the Truckee River upstream of Floriston.

Little Truckee River flow between Stampede Dam and Boca Reservoir varies with Stampede Reservoir operations. Aerial photographs of the Little Truckee River were taken August 31, 1977; fall 1998; July 2002; and December 2005. Geologists from CDWR evaluated the photographs for changes in river plan form and stability of the Little Truckee River (CDWR, 2005). The evaluation revealed only normal changes in river plan form and stability over the 28-year period; no evidence of bank erosion or channel instability was identified as a result of variability of releases from Stampede Reservoir.

The Newlands Project and channel modifications have influenced sedimentation of the Truckee River from Reno to Pyramid Lake. The lowering of Pyramid Lake caused base-level lowering of the Truckee River. The lower-most reaches of the Truckee River incised in response to the base-level lowering. The high sediment loads carried by the lower Truckee River greatly accelerated the creation of the Truckee River delta. Channel incision from Numana Dam to Pyramid Lake has resulted in unstable banks and loss of riparian habitat.

Many sediment-related problems exist in the Truckee River from Derby Diversion Dam to Pyramid Lake, including scouring of the riverbed in the lower channel. Bank erosion caused by high flows is severe in much of the river downstream from Wadsworth. During long periods of low flow, new flood plains and river channels develop. These areas, which are narrower and less defined than historically, generally do not have the capacity to control large flood events. During floods, extensive erosion and migration of these new channels (the gradual change of channel course) occur. In general, greater flows result in greater sediment transport capability and, therefore, changes in erosion and deposition patterns. Sediment erosion and transport are greatest during floods that follow prolonged periods of low flows.

C. Truckee River Delta Formation at Pyramid Lake

At the point of inflow, the Truckee River currently is building a delta northward into Pyramid Lake. (A delta is a deposit, partly on the land surface, built by a river flowing into an estuary, lake, or reservoir.) At times, the river channel through the delta is shallow, braided, and poorly defined, and upriver passage of cui-ui and LCT during the spawning season is impeded or precluded. Also, fish attempting to pass through the delta are easy prey for white pelicans.

Decreased inflow caused the elevation of Pyramid Lake to recede from 3870 feet in 1910 to 3796 feet in 1994 (observed data). The decline has led to erosion and headcutting upstream of Pyramid Lake, which, in turn, has resulted in channel degradation and incision of a pre-existing delta complex between Pyramid Lake and Nixon. Headcutting is the sudden change in elevation or knickpoint at the leading edge of a gully. Headcuts can range from less than an inch to several feet high, depending on several factors. Consequently, substantial amounts of locally eroded sediment are added to the normal sediment load of the Truckee River. Deposition of this combined sediment load has formed the delta at the mouth of the Truckee River. This locally eroded sediment was greatly reduced after construction of Marble Bluff Dam in 1975, which controlled upstream headcutting. The delta is about 4,000 feet wide at the mouth, 2,500 feet wide at the head, and about 13,000 feet long.

Change in areal extent of the delta depends on the interaction of several factors, including (1) fluctuation pattern of lake elevation and (2) erosion and sediment inflow. As water elevation decreases, more of the existing delta becomes exposed. However, a decrease in water elevation changes the hydraulic conditions at the river/lake confluence. More specifically, a decrease causes a drawdown effect, resulting in higher water velocities, increased erosion, and, thus, movement of the delta farther downstream into the lake. An increase in average lake elevation will have the opposite effect. Initially, the areal extent of exposed delta will decrease as it is submerged. But the increased water elevation will cause a backwater effect, resulting in lower water velocities, increased deposition farther upstream, and movement of the delta farther upstream into the river channel.

In general, increased erosion and, thus, sediment inflow to the lake, will increase the area extent of the delta. Decreased erosion and sediment inflow will have the opposite effect.

Flows entering Pyramid Lake carry sediment of varying concentrations. Because the lake has no outlet, all sediments entering Pyramid Lake are deposited there. The coarsest sediment particles (sand and gravels) entering the lake deposit first and form the Truckee River delta. Finer sediment particles (silt and clay) are transported further in the lake and deposit in deeper water.

D. Carson River

Before construction of Lahontan Dam, flows in the Carson River downstream from the dam were subject to sudden and dramatic changes. Uncontrolled spring runoff temporarily inundated large sections of Lahontan Valley, supporting wetland habitats. During these large seasonal events, sediment load would also increase and deposit in wetland areas.

The natural hydrologic cycle of the Carson River downstream from Lahontan Reservoir (lower Carson River) has been completely altered. Most flow in the lower Carson River occurs during the irrigation season, from April through September, with the maximum flows in May and June. Thus, the greatest potential for erosion of the lower Carson River also is in these months. The greatest likelihood of erosion is during avection thunderstorm floods (when a large spring or summer rainfall event occurs with snow still on the ground; because the rain cannot infiltrate the snow-covered ground, it runs off quickly, causing extreme flooding). However, the lower Carson River does not currently cause much sedimentation or erosion because the water from the river is routed through 381 miles of canals and laterals (FWS, 1996). Substantial streambank erosion did occur in the upper Carson River during the January 1997 flood event. Operations of the Truckee River under TROA would have little effect on Lahontan Reservoir operations and, therefore, would have little effect on the dynamics of sedimentation or erosion at Lahontan Dam and Reservoir and the lower Carson River. Therefore, sedimentation or erosion at Lahontan Dam and Reservoir and the lower Carson River are not discussed in "Environmental Consequences."

II. Environmental Consequences

Modifying operations of Truckee River reservoirs could affect the elevations of lakes and reservoirs and the quality, quantity, timing, and duration of flows. Changes in elevation at Lake Tahoe, when combined with wind-induced waves, could affect shoreline erosion. Increased flows over a long period or during a short-duration flood event could cause riverbanks or channel beds to erode at an increased rate. Some of the sediment load resulting from this erosion could be deposited in less steep reaches downstream, which could damage fish habitat, decrease channel capacity, and increase Truckee River delta growth. Conversely, decreased flows could cause increased sediment deposition, which could decrease channel capacity and foul gravels used as fish spawning beds.

Information on erosion and sediment transport in the Truckee River basin was limited, particularly relative to delineating geomorphology of the river and use of sediment transport models. Overall future changes in channel stability and plan form are assumed to be minimal, and most changes in sediment dynamics would be due to channel-forming floods generally associated with a 2- to 5-year flood rather than daily operations. None of the action alternatives would affect flood flows and, therefore, should not affect sediment dynamics.

A. Introduction

This analysis evaluated the effects of changes in water elevation and flows on sedimentation and erosion using following the indicators:

- Shoreline erosion at Lake Tahoe, as measured by Lake Tahoe water surface elevation

- Stream channel erosion and sediment transport capacity in representative reaches of the Truckee River, as determined by average monthly flows in very wet hydrologic conditions (5-percent probability of exceedence) and by evaluation of aerial photographs of the Little Truckee River

- Truckee River delta formation at Pyramid Lake, as measured by water surface elevation and inflows to Pyramid Lake

The following sections describe the indicators and the methods used to analyze them. Data used in the analyses include water surface elevations, reservoir releases, flows, and inflow to Pyramid Lake generated from the operations model.

B. Summary of Effects

Analysis of operations model results, in general, shows the following:

Shoreline erosion at Lake Tahoe would not increase under No Action, LWSA, or TROA; water quality would not be degraded; and the maximum elevation at which the lake is currently operated would not be exceeded.

Erosion and sediment transport in the Truckee River from Donner Creek to the Little Truckee River confluence would not differ significantly under any alternative.

In the Little Truckee River from Stampede Dam to Boca Reservoir and the Lockwood reach of the Truckee River, erosion and sediment transport would not be significantly affected under any of the alternatives.

In the Spice reach, erosion and sediment transport would not be affected because there is no known sediment source to influence this reach.

In the Nixon reach, erosion and sediment transport would not be significantly affected under any of the alternatives. Moreover, operations model results show that average annual flows are greater under TROA; these greater flows could promote the expansion of riparian vegetation, which, in turn, would have a stabilizing effect on the river channel and reduce sediment production.

The higher water surface elevation expected under TROA could improve the connectivity between the Truckee River and Pyramid Lake for fish migration and spawning; connectivity could be adversely affected under No Action and LWSA. Other aspects of Truckee River delta dynamics would not be affected under the alternatives.

Table 3.31 summarizes the effects of the alternatives on sedimentation and erosion.

C. Shoreline Erosion at Lake Tahoe

1. Method of Analysis

Shoreline erosion at Lake Tahoe was evaluated by comparing the end-of-month water surface elevations of Lake Tahoe in very wet (5-percent exceedence) and median (50-percent exceedence) hydrologic conditions under current conditions and the alternatives. Elevations were generated from the operations model. Very wet, rather than wet, hydrologic conditions were analyzed because the lake would be higher in these hydrologic conditions; thus, shoreline erosion would be more likely to occur. Water surface elevations in dry hydrologic conditions would be too low to affect shoreline erosion.

Table 3.31—Summary of effects on sedimentation and erosion

Stream reach	Current conditions	No Action	LWSA	TROA
Shoreline erosion at Lake Tahoe				
	Minimal	No manmade induced degradation of any water quality parameters	Same as under No Action	Same as under No Action
Stream channel erosion and sediment transport capacity				
Truckee River from Donner Creek to the Little Truckee River	No overall effect	No overall effect	Same as under No Action	No significant effect
Little Truckee River from Stampede Dam to Boca Reservoir	No overall effect	No overall effect	No overall effect	No overall effect
Spice	No overall effect	Potential significant effect	Same as under No Action	No overall effect
Lockwood	No overall effect	No significant effect	Same as under No Action	No significant effect
Nixon	No overall effect	No significant effect	Same as under No Action	No significant effect
Truckee River delta dynamics at Pyramid Lake				
	No effect	Potential adverse effect on connectivity between the Truckee River and Pyramid Lake	Same as under No Action	Improved connectivity between Truckee River and Pyramid Lake for fish migration and spawning

An increase in elevation, if significant, could potentially increase shoreline erosion by exposing more fine sediment of the backshore area to wave erosion. Based on studies by Adams (2003), the potential for shoreline erosion at Lake Tahoe exists when the lake is between elevation 6627 and 6629 feet.

2. Threshold of Significance

An effect on shoreline erosion at Lake Tahoe was considered significant if the water surface elevation was at least 0.25 foot higher, on a monthly basis, under the alternatives than under current conditions, or under the action alternatives than under No Action. This difference is thought to produce a measurable increase in shoreline erosion, as described in detail by Adams (2003), included in the Sedimentation and Erosion Appendix.

3. Model Results

Table 3.32 presents operations model results for end-of-month water surface elevations in Lake Tahoe in very wet and median hydrologic conditions.

Table 3.32—Lake Tahoe end-of-month water surface elevations (msl)

Month	Current conditions	No Action	LWSA	TROA
Very wet hydrologic conditions				
October	6228.40	6228.37	6228.37	6228.36
November	6228.22	6228.30	6228.30	6228.28
December	6228.30	6228.34	6228.34	6228.34
January	6228.41	6228.44	6228.44	6228.45
February	6228.49	6228.49	6228.49	6228.51
March	6228.65	6228.65	6228.65	6228.69
April	6228.75	6228.75	6228.75	6228.75
May	6229.00	6229.00	6229.00	6229.00
June	6229.00	6229.00	6229.00	6229.00
July	6229.00	6229.00	6229.00	6229.00
August	6228.78	6228.79	6228.79	6228.77
September	6228.50	6228.51	6228.51	6228.50
Median hydrologic conditions				
October	6226.98	6226.99	6226.98	6227.16
November	6226.98	6226.94	6226.94	6227.15
December	6226.96	6226.91	6226.91	6227.12
January	6227.31	6227.21	6227.21	6227.31
February	6227.32	6227.25	6227.25	6227.39
March	6227.37	6227.34	6227.33	6227.41
April	6227.42	6227.40	6227.40	6227.52
May	6228.07	6228.07	6228.07	6228.11
June	6228.55	6228.49	6228.48	6228.52
July	6228.34	6228.30	6228.30	6228.33
August	6227.98	6227.94	6227.94	6227.96
September	6227.57	6227.52	6227.52	6227.61

4. Evaluation of Effects

a. No Action

Operations model results show that Lake Tahoe exceeds elevation 6627 feet, the threshold for potential shoreline erosion, in very wet hydrologic conditions under both No Action and current conditions. However, the lake is slightly higher under No Action in November, December, January, August, and September than under current conditions. In median hydrologic conditions, elevations from January through September exceed the threshold. However, none of the differences between No Action and current conditions are greater than 0.25 foot, the threshold of significance. On the basis of these results, the potential for shoreline erosion under No Action is essentially the same as under current conditions.

b. LWSA

In both very wet and median hydrologic conditions, Lake Tahoe's end-of-month elevations are about the same under LWSA and No Action; thus the potential for shoreline erosion would be the same. Under LWSA, elevations are slightly higher from November through January than under current conditions and are almost the same in other months. Any differences are so small that no change in shoreline erosion is expected.

c. TROA

In very wet hydrologic conditions, Lake Tahoe's end-of-month elevations do not differ by more than 0.08 foot among TROA, No Action, or current conditions. Thus, no increase in shoreline erosion is expected, and there would be no degradation of water quality under any alternative. In median hydrologic conditions, Lake Tahoe's elevation exceeds 6627 feet in all months under TROA, compared to only the months of October, November, and December under current conditions. However, the differences are not greater than 0.18 foot. Likewise, Lake Tahoe's elevation does not differ by more than 0.21 foot between TROA and No Action. Therefore, no increase in shoreline erosion is expected under TROA.

In median hydrologic conditions, the three water surface elevation comparisons show differences in proportions of affected shoreline angles (Adams, 2003). Water surface elevations under TROA are about 0.013 feet to 0.17 foot higher than under No Action or current conditions. Under TROA, approximately 84 to 91 percent of the measured shoreline angles and beach ridges would not be affected. Under No Action and current conditions, 90 to 96 percent of the sites would not be affected. Adams (2003) concludes that implementing TROA would have no measurable effects on the shoreline erosion at Lake Tahoe and would not result in any man-induced degradation of the water quality. Consequently, because TROA would not have a measurable effect on sedimentation in Lake Tahoe, TROA would not have an adverse effect on existing beneficial uses associated with Lake Tahoe, or affect the attainment of California or Nevada water quality objectives for sedimentation. (See the Sedimentation and Erosion Appendix for further discussion.)

5. Mitigation

No mitigation would be required because no man-induced degradation of the water quality of Lake Tahoe and no measurable changes in shoreline erosion would occur under any of the alternatives. The maximum water surface elevation at which the lake is currently operated would never be exceeded under any alternative. Reservoir operations under TROA would not adversely affect the non-degradation objectives developed to maintain the outstanding qualities of Lake Tahoe, as an ONR.

D. Stream Channel Erosion and Sediment Transport

1. Method of Analysis

The difference in sediment transport capacity among the alternatives and current conditions was evaluated using average monthly flows in representative reaches of the Truckee River in very wet hydrologic conditions, generated from the operations model. Very wet hydrologic conditions were selected because they best reflect those conditions that affect erosion and sediment transport—channel-forming floods generally associated with a 2- to 5-year flood. The difference in sediment transport capacity was computed as a function of flow (raised to the second or third power). Greater average monthly flows (assuming that the variability in daily flows within a month does not change) could increase sediment transport capacity and, potentially, result greater erosion of the river channel.

2. Threshold of Significance

For stream channel erosion and sediment transport, an effect was considered significant if it would cause widespread and measurable channel erosion or deposition. Widespread and measurable channel erosion is expected to occur under the alternatives when sediment transport capacity is at least 10 percent greater than under current conditions, and the streambed is not already armored. Widespread and measurable channel deposition is expected to occur under the alternatives when sediment transport capacity is at least 10 percent less than under current conditions and there is a substantial upstream source of river or tributary sediment. For example, a channel downstream from a dam would not have an upstream source of sediment and the bed material sediments would be armored (not erodible). A decrease in sediment transport capacity for a river downstream from a dam would not result in deposition without a large source of tributary sediment. Because of its armored condition, this methodology was not used for the Little Truckee River. See Section II.D.4.a(2) for a discussion of the method of analysis used to evaluate the Little Truckee River.

The following reaches were evaluated because they are considered representative of the entire river. Map 3.1 shows the locations of the reaches.

Truckee River: Donner Creek to Little Truckee River confluence
Little Truckee River: Stampede Dam to Boca Reservoir

Truckee River: Reno-Sparks to McCarran Boulevard (Spice)
Truckee River: McCarran Boulevard to Derby Diversion Dam (Lockwood)
Truckee River: Derby Diversion Dam to Pyramid Lake (Nixon)

3. Model Results

Table 3.33 presents weighted average differences in sediment transport capacity for the representative river reaches in very wet hydrologic conditions.

Table 3.33—Weighted average differences in sediment transport capacity (very wet hydrologic conditions)

Stream reach	No Action, compared to:	LWSA, compared to:		TROA, compared to:	
	Current conditions	Current conditions	No Action	Current conditions	No Action
Truckee River: Donner Creek to Little Truckee River	2 to 3% less	2 to 3% less	No change	2 to 4% greater	4 to 7% greater
Little Truckee River: Stampede Dam to Boca Reservoir	No overall effect	No overall effect	No overall effect	No overall effect	No overall effect
Spice	7 to 10% less	7 to 11% less	0 to 1% less; no effect	1 to 2% greater	8 to 13% greater
Lockwood	3 to 6% less	4 to 6% less	0 to 1% less; no change	3 to 5% greater	7 to 11% greater
Nixon	3 to 5% less	3 to 5% less	No change	3 to 5% greater	7 to 11% greater

As discussed in Section II.2, "Threshold of Significance," an effect was considered significant when sediment transport capacity was at least 10 percent greater than under current conditions, and the streambed is not already armored, or when sediment transport capacity was at least 10 percent less than under current conditions and there is a substantial upstream source of river or tributary sediment. Effects under LWSA and TROA also were compared to No Action, but, again, an effect was considered significant only if it differed by 10 percent or more from current conditions.

4. Evaluation of Effects

a. No Action

(1) Truckee River: Donner Creek to Little Truckee River Confluence

Operations model results show that annual sediment transport capacity under No Action is 2 to 3 percent less than under current conditions in very wet hydrologic conditions. On the basis of these results, erosion and sediment transport in this reach under No Action likely would be about the same as under current conditions.

(2) Little Truckee River: Stampede Dam to Boca Reservoir

As discussed previously, aerial photographs of the Little Truckee River were taken August 31, 1977; fall 1998; July 2002; and December 2005. Geologists from the California Department of Water Resources evaluated the photographs to assess any changes in river plan form and stability of the Little Truckee River (CDWR, 2005). The evaluation revealed only normal changes in river plan form and stability over the 28-year period. Because no evidence of bank erosion or channel instability was identified, it was determined no effects would occur under No Action, LWSA, or TROA.

(3) Spice

Annual sediment transport capacity under No Action is 7 to 10 percent less than under current conditions in very wet hydrologic conditions. Thus, more sediment deposition could occur in this reach than under current conditions, but because a source of sediment likely does not exist upstream, substantial deposition is not likely.

(4) Lockwood

Annual sediment transport capacity under No Action is 3 to 6 percent less than under current conditions in very wet hydrologic conditions. On the basis of these results, erosion and sediment transport in this reach would not differ significantly from current conditions.

(5) Nixon

Annual sediment transport capacity under No Action is about 3 to 5 percent less than under current conditions in very wet hydrologic conditions. On the basis of these results, erosion and sediment transport in this reach would not differ significantly from current conditions.

b. LWSA

(1) Truckee River: Donner Creek to Little Truckee River Confluence

Annual sediment transport capacities are the same under LWSA and No Action, suggesting that erosion and sediment transport in this reach likely would be the same as well.

Operations model results show that annual sediment transport capacity under LWSA is 2 to 3 percent less than under current conditions in very wet hydrologic conditions, suggesting that erosion and sediment transport in this reach would not differ significantly from current conditions.

(2) Little Truckee River: Stampede Dam to Boca Reservoir

No effects would occur, as described under No Action.

(3) Spice

Annual sediment transport capacity under LWSA is essentially the same as No Action when compared to current conditions in very wet hydrologic conditions; thus, erosion and sediment transport in this reach likely would be the same as well.

Annual sediment transport capacity under LWSA is 7 to 11 percent less than under current conditions in very wet hydrologic conditions. Thus, sediment transport in this reach likely would be less than under current conditions, and sediment deposition is possible. However, because a source of sediment does not exist upstream, substantial deposition is not likely.

(4) Lockwood

Annual and monthly sediment transport capacity under LWSA is nearly the same as under No Action, suggesting that erosion and sediment transport in this reach would be the same as well.

Annual sediment transport capacity under LWSA is 4 to 6 percent less than under current conditions in very wet hydrologic conditions, suggesting that erosion and sediment transport in this reach would not differ significantly from current conditions.

(5) Nixon

Annual sediment transport capacity under LWSA is about the same as under No Action, suggesting that erosion and sediment transport in this reach would be the same as well.

Annual sediment transport capacity under LWSA is 3 to 5 percent less than under current conditions in very wet hydrologic conditions, suggesting that erosion and sediment transport in this reach would not differ significantly from current conditions.

c. TROA

(1) Truckee River: Donner Creek to Little Truckee River Confluence

Annual sediment transport capacity under TROA is 4 to 7 percent greater than under No Action in very wet hydrologic conditions.

Annual sediment transport capacity under TROA is 2 to 4 percent greater than under current conditions in very wet hydrologic conditions. Thus, erosion and sediment transport in this reach would not differ significantly from current conditions. Consequently, TROA is not expected to impair the attainment of water quality objectives or have an adverse effect on beneficial uses within the reach of the Truckee River from Lake Tahoe to the California/Nevada State line.

(2) Little Truckee River: Stampede Dam to Boca Reservoir

No effects would occur, as described under No Action.

(3) Spice

Annual sediment transport capacity under TROA is 8 to 13 percent greater than under No Action in very wet hydrologic conditions.

Annual sediment transport capacity under TROA is 1 to 2 percent greater than under current conditions in very wet hydrologic conditions. Thus, erosion and sediment transport in this reach would be about the same as under current conditions.

(4) Lockwood

Annual sediment transport capacity under TROA is 7 to 11 percent greater than under No Action in very wet hydrologic conditions.

Annual sediment transport capacity under TROA is 3 to 5 percent greater than under current conditions in very wet hydrologic conditions, suggesting that erosion and sediment transport in this reach would not differ significantly from current conditions.

(5) Nixon

Annual sediment transport capacity under TROA is 7 to 11 percent greater than under No Action in very wet hydrologic conditions.

Annual sediment transport capacity under TROA is 3 to 5 percent greater than under current conditions in very wet hydrologic conditions, suggesting that erosion and sediment transport in this reach would not differ significantly from current conditions. Moreover, overall, operations model results indicate that, under TROA, average annual flows are greater than under current conditions or the alternatives. These greater flows could promote the expansion of riparian vegetation, which, in turn, would have a stabilizing effect on the river channel and actually reduce, rather than increase, sediment production.

5. Mitigation

No mitigation would be required because, overall, no significant adverse effects would occur under the alternatives.

E. Truckee River Delta Formation at Pyramid Lake

For this indicator, operations model results for Pyramid Lake water surface elevation and inflows were analyzed to determine the potential for Truckee River delta formation.

The water surface elevation of Pyramid Lake at the end of the period of analysis under the alternatives was compared to its end-of-period elevation under current conditions. (Simulated elevations were generated by the operations model.) A difference in elevation between the alternatives and current conditions represents conditions in which the delta could be affected by sediment transport and erosion. The effect on Truckee River delta formation was considered significant if the elevation of Pyramid Lake was 0.5 foot or more lower under the alternatives than under current conditions.

As shown in table 3.34 below and on figure 3.20 in “Surface Water,” operations model results indicate that, compared to current conditions, the elevation of Pyramid Lake is 2.57 feet lower under No Action; 2.94 feet lower under LWSA; and 1.68 feet higher under TROA at the end of the period of analysis. The lower elevation under No Action and LWSA could adversely affect the connectivity between the Truckee River and Pyramid Lake. The higher elevation under TROA would improve the connectivity between the river and lake for fish migration and spawning.

Table 3.34—Difference between current conditions and alternatives in operations model results for the elevation of Pyramid Lake at the end of the period of analysis

Current conditions	No Action	LWSA	TROA
0.00	-2.57	-2.94	1.68

Sediment transport capacity, as measured by inflows to Pyramid Lake, shows no effect on delta formation. The change in annual sediment transport capacity under the all of the alternatives does not exceed threshold of significance (difference of 10 percent or more compared to current conditions). Therefore, the potential for erosion for this reach does not differ significantly from current conditions (table 3.31, Nixon reach).

No mitigation would be required because no significant adverse effects would occur under any of the alternatives.

BIOLOGICAL RESOURCES

Modifying operations of Truckee River reservoirs could affect the quality, quantity, timing, and duration of flow and the water in lakes and reservoirs. Such changes could potentially affect the habitat and life cycles of aquatic life associated with rivers and tributaries, lake and reservoirs, streamside and wetland habitats and their associated wildlife, and endangered, threatened, and other special status species.

Flow is the most important aspect of a river system because it influences both the physical structure of the substrate (the base on which an aquatic organism lives) and water quality. These two factors help determine the types of plant and invertebrate life present. Other factors that affect aquatic life include stream gradient; water depth; water temperature; water chemistry (e.g., dissolved oxygen, organic and inorganic nutrients, and salinity); substrate type; cover; seasonal variability; aquatic plant and invertebrate abundance; and the presence of other species that are food sources, competitors, or predators. All of these factors interact, and species respond differently to any given set of environmental conditions at different stages of their life cycles.

If other factors influencing temperature are relatively stable, high flow generally results in colder, well-oxygenated water that supports organisms that prefer coldwater conditions. Seasonal excessively high flows, associated with high storm runoff, may scour the river channel, altering the substrate for invertebrates and spawning fish, and removing vegetation. With very low flows, habitat area is reduced, water temperature may increase beyond the tolerance of many species, DO concentrations may decline, and organisms may become stranded in isolated pools. Stranding may result in death or increased stress resulting in lower productivity from oxygen depletion, high water temperature, or increased predation by birds and other predators that can easily reach the trapped invertebrates or fish. However, indigenous species evolved with and adapted to the highly variable flows of the unregulated river system.

Reservoir operations directly affect biological resources associated with upstream lakes and reservoirs (Lake Tahoe, Independence and Donner Lakes, and Prosser Creek, Stampede and Boca Reservoirs) through changes in storage. The release of water from upstream lakes and reservoirs also indirectly affects the amount of water that arrives at Pyramid Lake and Lahontan Reservoir.

The following sections assess the effects of the alternatives on fish in the Truckee River and its affected tributaries; on fish of lakes and reservoirs; on riparian (streamside and wetland) habitat and riparian-associated wildlife; and on endangered, threatened, and other special status species.

Fish in Truckee River and Affected Tributaries

I. Affected Environment

Both native and non-native fish species are found in the Truckee River and its tributaries. Common native fish of the Truckee River include Paiute sculpin, Lahontan redside shiner, Tahoe sucker, speckled dace, and mountain sucker. Recent information shows that mountain whitefish is also common; however, population levels can vary dramatically over time depending on river conditions (Hiscox, 2003; Tisdale, 2003).

Rainbow and brown trout are the most common non-native fish species in the Truckee River from Lake Tahoe to Vista and in many upstream tributaries; carp and mosquitofish are common in the Truckee River downstream from Vista. Additional information on the relative abundance of native and non-native fish in the Truckee River and its upstream tributaries is presented in tables 3.35 and 3.36. The Truckee River from the confluence with Trout Creek to the confluence with Gray Creek has been designated a Wild Trout Water by the California Fish and Game Commission.

Fish species native to the Truckee River are adapted to the highly variable flows of the unregulated river system. Since construction of dams and reservoirs and channelization of portions of the Truckee River, fish have had to cope with regulated flow patterns that differ from natural flows. These changes and the secondary effects they have caused (for example, higher water temperatures), along with the lowering of the elevation of Pyramid Lake, have contributed to the reduction in populations of many native fish.

Beginning in the late 1800s, many non-native fish species were introduced into the Truckee River basin (Truckee River Basin Recovery Implementation Team [TRIT], 2003; Sigler and Sigler, 1987). Rainbow and brown trout have been the two most successful species; natural recruitment is supplemented with annual plantings of hatchery-reared individuals in certain areas to improve recreational fishing (NDOW, 1992b; Wickwire, 1995). Introduced trout are reported to adversely affect the distribution and abundance of native aquatic species in the Sierra Nevada (Moyle, 2002; Knapp, 1994). In an attempt to reduce these impacts, NDOW is experimenting with stocking triploid (sterile) rainbow trout, which will reduce hybridization with native Lahontan cutthroat trout.

Under current conditions, spawning, incubation, and rearing habitat for native mountain whitefish and non-native brown and rainbow trout in Donner and Prosser Creeks and the Little Truckee River is relatively degraded and reduced in extent compared to historic conditions (CDFG, 1996b). Donner and Prosser Creeks could potentially provide spawning and fry rearing habitat for trout resident to the Truckee River. In the Truckee River, spawning and fry rearing habitat also is degraded, and many of the complex pool habitats critical to juvenile survival have been lost. Available habitat for spawning, incubation, and rearing of salmonid adults is especially restricted during severe drought.

Table 3.35—Relative abundance of native and non-native fish species in the mainstem Truckee River[1,2]

Species	Lake Tahoe to State line	State line to Vista	Vista to Derby Diversion Dam	Derby Diversion Dam to Marble Bluff Dam
Native fish				
Lahontan cutthroat trout	U-P	U-P	U-P	U-P
Mountain whitefish	C[3]	C	U	U
Paiute sculpin	C	C	none	none
Lahontan redside shiner	C	C	C	C
Speckled dace	C	C	C	C
Lahontan tui chub	none	none	none	U
Tahoe sucker	C	C	C	C
Mountain sucker	U	C	C	C
Cui-ui	none	none	none	U-S
Non-native fish				
Rainbow trout	C	C-R[4]	C	C
Brown trout	C	C-R	C-R	C-R
Brook trout	U	U	none	none
Kokanee salmon	U	none	none	U
Goldfish	none	none	U	none
Carp	none	U	C	C
Golden shiner	none	none	U	none
Largemouth bass	none	U	U	U
Smallmouth bass	U	U	U	U
Green sunfish	none	U	U	U
Black crappie	none	U	U	U
Mosquitofish	none	none	C	C
Channel catfish	none	none	U	U
Brown bullhead	none	U	U	U
Fathead minnow	none	U	C	C

[1] Sources: Hiscox, 2003; Molini, 1998; Scoppettone and Bailey, 1983; Tisdale, 2003.
[2] Occurrence classification:
P = Planted (non-reproducing)
R = Planted for recreational fishing
S = Spawning only
C = Common
U = Uncommon
[3] Based on the most recent survey information; however, population levels appear to have wide variation and may be considered uncommon during other periods.
[4] NDOW began stocking triploid (sterile) fish in 2004.

Table 3.36—Relative abundance of native and non-native fish species in the tributaries to the upper Truckee River[1,2]

Species	Donner Creek	Prosser Creek	Independence Creek	Upper Little Truckee River	Lower Little Truckee River
Native fish					
Lahontan cutthroat trout	none	none	U-S	none	U
Mountain whitefish	none	none	none	U	none
Paiute sculpin	C	none	none	C	C
Lahontan redside shiner	none	C	none	C	C
Speckled dace	none	C	none	C	C
Tahoe sucker	none	C	none	C	U
Mountain sucker	none	U	none	U	U
Non-native fish					
Rainbow trout	C	C	none	C	U-P
Brown trout	C	C	none	C	C
Brook trout	C	U	C	U	U
Kokanee salmon	none	none	none	C-S[3]	U

[1] Sources: Hiscox, 2003; Molini, 1998; Scoppettone and Bailey, 1983;Tisdale, 2003.
[2] P = Planted (non-reproducing); R = Planted for recreational fishing; S = Spawning only; C = Common; U =Uncommon
[3] Based on recent survey information; however, population levels appear to have wide variation and may be considered uncommon during other periods.

Water temperature and spawning requirements for selected fish species are summarized in table 3.37. Tributaries to the Truckee River in California are important spawning areas for salmonids and other fishes; therefore, effects on these tributaries during spawning periods may affect future fish populations throughout the system.

II. Environmental Consequences

A. Introduction

CDFG and NDOW recommended flows for reaches (map 3.1) within each agency's jurisdiction, except reach 14, where habitat/flow relations for the representative fish species are not available (table 3.35; CDFG, 1996b; Warren, 1994; FWS, 1993). Flow recommendations for brown and rainbow trout were derived using the Instream Flow Incremental Methodology (IFIM). Brown and rainbow trout were selected to represent spring and fall/winter spawning salmonids in the Truckee River and because their spawning, incubation, and rearing stages are sensitive to changes in flow. Moreover,

Table 3.37—Spawning requirements of selected fish species in the Truckee River basin

Species	Habitat	Spawning location	Spawning season/ temperature requirements	Spawning habitat	Fry habitat
Native fish					
Lahontan cutthroat trout	Cold/cool water	Streams	Spring-summer: April-July, 46-61 °F	Gravel riffles	Edge habitat in association with shallow water, low flows, and abundant food
Mountain whitefish	Cold, clear water	Lakes, streams	Fall: October-November, 34-52 °F	Riffles (streams); wave-washed shallows (lakes)	Deep area of lakes, shallow backwaters of streams
Paiute sculpin	Coldwater bottom dweller	Lakes, streams	Spring-summer: May-August, 39-45 °F	Wave-swept littoral areas or stream mouths (lakes); loose gravel/rubble (streams)	Gravels and rocks
Lahontan redside shiner	Variable shallow areas	Lakes, streams	Spring-summer: May-August, 55-75 °F	Sand/gravel shallows	Quiet shallows with cover in lakes/streams
Speckled dace	Variable shallow areas	Lakes, streams	Spring-summer: June-July, 46 °F+	Shallow gravels (lakes); gravel edges of riffles (streams)	Quiet shallows or swampy coves of lakes; channels between large rocks and macrophytes of streams
Lahontan tui chub	Variable	Lakes, streams	Spring-summer: April-July, 43-55 °F	Over macrophyte beds or algae covered rocks and gravel; sandy bottoms and stream mouths (Lake Tahoe)	Shallow weedy areas with cover
Tahoe sucker	Variable	Lakes, streams	Spring-summer: March-August, 52-73 °F	Rocks/gravel riffles or gravel bottom lakes	Flooded vegetation resulting from sustained high flows
Mountain sucker	Variable	Streams	Summer: June-August, 52-66 °F	Gravel riffles upstream of pools	Edge habitat and pool macrophyte beds
Cui-ui	Only in Pyramid Lake, except when spawning	Lower Truckee River	Spring: March-June, 57-63 °F	Gravel	Littoral area of Pyramid Lake

data on life stage requirements, required to analyze the effects of flow are not available for most other species. The relation between flow and fish habitat was developed using the Physical Habitat Simulation System (PHABSIM), a set of software and methods that allows computation of relations between flow and physical habitat for various life stages of fish (Bovee and Milhous 1978; Bovee 1982; Stalnaker et al. 1995).

Preferred flows were selected for each reach of the Truckee River and its tributaries based on the flow needs of brown and rainbow trout. Maximum and minimum flows were determined by the limits of the flow range that can sustain existing levels of fish populations. Table 3.38 presents maximum, preferred, and minimum flows. Only reaches 1 through 14 were analyzed (map 3.1); the Nixon reach was not assessed because its water temperatures are too high to support reproducing brown and rainbow trout.

Different flows are recommended for different seasons because each fish life stage has different requirements. In general, maximum flows are twice that of optimum or preferred flows. Increases and decreases in flows require ramping rates designed to avoid flushing fish downstream or stranding fish on high ground. When flows are greater than maximum, ramping can occur at any rate without causing additional damage. Preferred flows provide optimum habitat for a specific life stage of the fish species. Minimum flows are the lowest seasonal flows under which the representative fish populations could be maintained. CDFG states, “Due to the substantial reduction in habitat availability at minimum flows (to 50 percent of optimum), it is imperative that flow management providing other than optimum (preferred) flow conditions be accompanied by a spawning and rearing habitat improvement program.”

CDFG had two primary objectives in developing its recommendations: (1) maintain self-sustaining brown and rainbow trout populations and (2) provide recruitment to other tributary trout populations (CDFG, 1996). CDFG defined the minimum flow threshold as follows: (1) for the Truckee River from Lake Tahoe to the State line and the Little Truckee River downstream from Stampede Reservoir, minimum flows were based, primarily, on juvenile rainbow trout habitat availability and, secondarily, on maintaining at least 50 percent of optimum conditions for other life stages; (2) for Donner, Prosser, and Independence Creeks, and for the Little Truckee River upstream of Stampede Reservoir, minimum flows were based on conditions that would not reduce any life stage (except adult rearing habitat availability) below 50 percent of optimum during any period. CDFG (1996) determined that a fish population would decline over time if habitat conditions were maintained below 50 percent of optimum, based on using PHABSIM.

NDOW also based its recommendations on data gathered using IFIM, as well as water temperature information for the Truckee River from the California-Nevada State line to Derby Diversion Dam (FWS, 1993). In reaches downstream from Sparks, NDOW assumed (based on field observations) that when summer flow drops below the recommended minimum, all fish will be lost in that reach, primarily due to elevated water temperature (Warren, 1994). The Biological Resources Appendix describes in detail how CDFG and NDOW developed their recommended flows.

Table 3.38—Maximum[1], preferred, and minimum spawning, incubation, and rearing flow (cfs) recommendations by CDFG[2] and NDOW for brown trout and rainbow trout in the Truckee River and its major tributaries (blank spaces indicate that the States have not made recommendations)

River reach/tributary	Brown trout						Rainbow trout					
	October-January			February-March			April-July			August-September		
	Spawning and incubation			Rearing			Spawning and incubation			Rearing		
	Max.	Pref.	Min.	Max.	Pref.	Min.	Max.	Pref.	Min.	Max.	Pref.	Min.
Little Truckee River, downstream from Stampede Reservoir	250	125	45	200	100	45	250	125	45	200	100	45
Little Truckee River, upstream of Stampede[3] Reservoir		90			50			90			30	
Donner Creek[4]	100	50	8				100	50	[6]8	20	10	[6]8
Prosser Creek[5]	100	50	25	70	35	25	150	75	12	60	30	25
Independence Creek	40	20	7	20	10	4	40	20	8	20	10	4
Truckee River from Lake Tahoe to Donner Creek[7]	600	300	75	500	250	75	600	300	75	500	250	75
Donner Creek to Little Truckee River	600	300	100	500	250	100	600	300	100	500	250	100
Truckee River from Little Truckee River to Trophy	600	300	150	500	250	150	600	300	150	500	250	150
Mayberry		200	100		200	100		300	200		300	200
Oxbow		200	100		200	100		300	200		300	200
Spice		200	100		200	100		250	150		250	150
Lockwood		350	250		350	250		350	250		350	250

[1] Maximum flow recommendations are only provided for the Truckee River in California.
[2] CDFG recommendations for reaches in California are for support of self-sustaining brown and rainbow trout fisheries.
[3] While minimum flows are specified in the IFIM report (CDFG, 1996), no controlled-release facility exists for this reach.
[4] California Dam Safety Requirements require that the gates at Donner Lake remain open from November 15 to April 15; minimum flow recommendations apply only from April 5 to November 15.
[5] Since physical constraints prevent releases between 12 cfs and 25 cfs, this is the minimum flow until the dam is modified to allow a minimum flow of 16 cfs throughout the year, which is recommended by the IFIM report (CDFG, 1996).
[6] Reduced to 5 cfs or natural inflow, whichever is less, when lake is projected to have less than 8,000 acre-feet of storage on Labor Day.
[7] Due to changes in the condition of the river channel since the IFIM studies were conducted, preferred flows in these reaches have been increased from the recommendations specified in the IFIM report (CDFG, 1996).

New flow recommendations developed by FWS were implemented in 2003 (TRIT, 2003). The purpose of these new flow recommendations, known as the six-flow regime, is to guide the management of Fish Water and, under TROA, Fish Credit Water releases in order to meet ecosystem requirements along the Truckee River. The flow targets under the six-flow regime are based on recommendations for the lower Truckee River (table 3.39), but when water is released to achieve these targets, it is in addition to flows released to meet other flow requirements; therefore it does not replace, but augments, flow already in the river. The six-flow regime emphasizes maintaining essential flows while attempting to mimic the river's natural hydrologic variability, given water availability in any particular year. While the six-flow regime considers the biological requirements of fish, it also incorporates ecosystem considerations, such as flows that enhance the establishment and maintenance of willow and cottonwoods. Regimes 1, 2, and 3 are intended to promote cui-ui spawning in above average, average, and below-average water years, respectively. In above-average and wetter years, the focus of the six-flow regime is on the gradual ramping down of spring and summer flows to facilitate willow and cottonwood recruitment. Regimes 4, 5, and 6 are recommended during dry, very dry, and extremely dry years, respectively. Under regimes 3 though 6, the management focus is on using available runoff to maintain year-around flows to benefit the ecosystem. For example, enhanced riparian growth and maintenance that result from greater summer and fall flows increase shading. In turn, increased shading lowers water temperatures. More detail on the six-flow regime and the process used to determine them is included in the discussion of cui-ui in "Endangered, Threatened, and Other Special Status Species" and in the Biological Resources Appendix.

Table 3.39—The ecosystem-based six-flow regime recommendations for the lower Truckee River (TRIT, 2003)

Month	Regime (cfs)					
	1	2	3	4	5	6
January	160	150	120	110	100	90
February	160	150	120	110	100	90
March	290	220	200	160	160	140
April	590	490	420	350	300	200
May	1000	800	600	530	400	300
June	800	600	500	400	270	170
July	300	300	300	200	150	120
August	200	200	200	200	150	110
September	170	170	120	110	100	100
October	160	150	120	110	100	100
November	160	150	120	110	100	90
December	160	150	120	110	100	90
Total (acre-feet)	249,000	211,800	176,400	150,000	121,800	96,000

Changes in flow within the Truckee River basin could significantly affect the amount of habitat available for various life stages of fish associated with rivers and tributaries. In addition, low flow in the Truckee River reach from Hunter Creek to East McCarran Boulevard could result in formation of anchor ice in winter and predation or death from high temperature or anoxia in summer.

To evaluate the potential effects on the non-native trout fishery in the Truckee River and its tributaries, the following indicators were chosen; the results of each analysis are described in this section. Potential effects of diversions from the Truckee River to TMWA's hydroelectric powerplants are not considered in the following indicators, but addressed separately at this end of this chapter in "Minimum Bypass Flow Requirements for TMWA's Hydroelectric Diversion Dams on the Truckee River."

- Frequency that preferred flows for various life stages of brown trout from October through March (fall/winter months) are achieved or exceeded without exceeding maximum flows
- Frequency that minimum flows for various life stages of brown trout from October through March (fall/winter months) are sustained
- Frequency that preferred flows for various life stages of rainbow trout from April through September (spring/summer) are achieved or exceeded without exceeding maximum flows
- Frequency that minimum flows for various life stages of rainbow trout from April through September (spring/summer) are sustained
- Frequency of flushing/stranding flows
- Frequency of low flows in winter months that increase the potential for anchor ice formation

B. Frequency that Preferred Flows for Various Life Stages of Brown Trout from October through March are Achieved or Exceeded Without Exceeding Maximum Flows

1. Summary of Effects

Analysis of operations model results for the frequency that preferred flows for brown trout are achieved or exceeded without exceeding maximum flows shows that under TROA, significant beneficial effects would occur in Donner Creek, where only the month of October was analyzed. No effects would occur under either No Action or LWSA. Table 3.40 summarizes these effects.

Table 3.40—Summary of effects: frequency that preferred flows for brown trout are achieved or exceeded without exceeding maximum flows, when specified (+ = significant beneficial effect, - = significant adverse effect)

	Compared to current conditions			Compared to No Action	
River reach/tributary	No Action	LWSA	TROA	LWSA	TROA
Truckee River from Lake Tahoe to Donner Creek	No effect				
Truckee River from Donner Creek to Little Truckee River					
Truckee River from Little Truckee River to Trophy					
Trophy					
Mayberry					
Oxbow					
Spice					
Lockwood					
Donner Creek (October only)	No effect		+	No effect	+
Prosser Creek	No effect				
Independence Creek					
Little Truckee River upstream of Stampede Reservoir					
Little Truckee River downstream from Stampede Reservoir					

2. Method of Analysis

The frequency that preferred flows for brown trout are achieved or exceeded without exceeding maximum flows from October through March (as generated by the operations model) was analyzed. Average monthly flows for each month from October through March were tallied if they were equal to or greater than the preferred flow and equal to or less than the maximum flow (when specified) for brown trout spawning, incubation, and rearing.

3. Threshold of Significance

Each stretch of river, or reach, can have different channel morphology and habitat conditions that can influence the effects of changes in flows on fish populations. Preferred flows provide the greatest amount of optimum habitat for brown and rainbow trout; however, trout can reproduce under less flows. Changes in trout populations due to changes in flows are dependent on several factors that must be taken into account for each situation. These include the following: (1) The frequency of achieving or sustaining preferred flows, both in relative differences and absolute values; (2) the possibility of recruitment of fish from other reaches (fish movement into a reach from other reaches and on-stream reservoirs); and (3) the possibility of lethal flows (i.e., a flow below the minimum or above the maximum). Thus, best professional judgment was required to weigh these differences in specific reaches and determine the significance of effects.

Examples of the relative and absolute differences in significance of changes in flows can be understood in the following examples. A 5-percent (absolute) difference in the frequency of flows may not be likely to have a significant effect on the trout population if the relative frequencies of achieving a flow are already high, such as the difference between 75 and 80 percent. However, when the frequencies are low, such as 25 percent or less, a 5-percent (absolute) difference will actually result in relative flow change of 20 percent or greater. When absolute frequency values are in the range of 30 to 70 percent, differences of only a few percentage points are unlikely to have a significant effect on trout species.

Large absolute differences in achieving preferred or sustained flows (15 percent or greater) are more likely to produce a significant effect in trout populations than lesser relative differences in flow (8 to 15 percent). Assigning a determination of significance at these lesser levels is more challenging. In such cases, the relative frequency of flows outside of the preferred range (lethal flows in particular) was considered within the analysis. Because lethal flows directly influence trout survival, a difference in their frequency in combination with a moderate difference in the frequency of flows that support spawning, incubation, and rearing, was considered to increase the potential for a measurable adverse effect. The underlying assumption is that while a moderate change in achieving or sustaining preferred flows may have a short-term effect on trout reproductive success, the magnitude of this effect on the overall trout population over the long-term would be offset to some degree if temperatures lethal to the fish population occur less frequently. However, an increase in the frequency of lethal temperatures was considered to increase the potential for adverse effects on spawning, incubation, and rearing in trout.

4. Model Results

Table 3.41 presents operations model results for the frequency (percent of months) that preferred flows for various life stages of brown trout from October through March (fall/winter months) are achieved or exceeded without exceeding maximum flows (when specified) in the Truckee River and its tributaries.

5. Evaluation of Effects

a. No Action

Operations model results show that, under No Action, preferred flows for brown trout are achieved about as frequently as under current conditions in all reaches of the Truckee River and its tributaries. There would be no effect.

Table 3.41—Frequency (percent of months) that preferred flows for brown trout from October through March are achieved or exceeded without exceeding maximum flows (when specified)

River reach/tributary	Current conditions	No Action	LWSA	TROA
Truckee River from Lake Tahoe to Donner Creek	10	11	11	6
Truckee River from Donner Creek to Little Truckee River	25	26	26	17
Truckee River from Little Truckee River to Trophy	58	58	57	45
Trophy	93	93	92	93
Mayberry	93	92	92	88
Oxbow	93	90	90	82
Spice	92	89	89	79
Lockwood	87	86	86	79
Donner Creek (October only)[1]	14	14	14	47
Prosser Creek	22	22	22	23
Independence Creek	18	18	18	18
Little Truckee River upstream of Stampede Reservoir	26	26	26	25
Little Truckee River downstream from Stampede Reservoir	22	22	22	22

[1] California Dam Safety Requirements require that the gates at Donner Lake dam remain open from November 15 to April 15. October is the only full spawning month in which Donner Lake releases can be controlled.

b. LWSA

Under LWSA, preferred flows for brown trout are achieved as frequently or about as frequently as under No Action and current conditions in all reaches of the Truckee River and its tributaries. There would be no effect.

c. TROA

Operations model results show that, in most reaches of the Truckee River and its upper tributaries, under TROA, preferred flows for brown trout are achieved about as frequently as under current conditions (differences of only a few percent). Such small differences do not constitute a significant effect. These reaches are not discussed further. Reaches with no effect also are not discussed.

Under TROA, preferred flows for brown trout are achieved 3 times more frequently in Donner Creek than under current conditions. Only the month of October was analyzed for Donner Creek because California Dam Safety Requirements preclude storing water in Donner Lake from November 15 to April 15, which precludes the possibility of controlled releases. As a result, brown trout spawning in Donner Creek should be enhanced, which would be significant beneficial effect under TROA.

In the two upper reaches of the Truckee River, operations model results show that, under TROA, preferred flows for brown trout are achieved slightly more than half of as frequently as under No Action or current conditions. Because preferred flows are achieved only 11 and 10 percent of the time under No Action and current conditions, respectively, the potential effects under TROA were examined on a monthly basis. Results show that potential adverse effects occur only in October when, based on Truckee River flow at Donner Creek, preferred flows for brown trout are achieved only 13 percent of the time under TROA, compared to 38 percent of the time under No Action, and 34 percent of the time under current conditions. CDFG states that if flows are not adequate for spawning in October, fish may hold in deep pools and spawn later when flows are greater (Hiscox, 2004). Therefore, while less frequent preferred flows may be adverse for spawning, incubation, and rearing of brown trout in one month in one reach, less frequent preferred flows under TROA do not constitute a significant adverse effect overall.

In a few reaches, the frequencies that preferred flows for brown trout are achieved differ by 8 to 13 percent. To better assess the significance of these differences, the frequency that lethal flows occur in these reaches also was evaluated. These reaches are discussed individually, as follows.

Truckee River from Little Truckee River to Trophy: In this reach, preferred flows for brown trout are achieved in 58 percent of the fall/winter months under current conditions compared to 45 percent under TROA, a difference of 13 percent. Lethal flows occur in 36 percent of the fall/winter months under current conditions, compared to 35 percent under TROA. Because this small difference in the frequency of lethal flows is not likely to have a significant effect on adult survival and recruitment from other reaches of the river is likely to occur, the moderate difference in the frequency of achieving preferred flows for brown trout in this reach is not considered a significant effect on the long-term survival of the brown trout population.

Oxbow: In the Oxbow reach, preferred flows for brown trout are achieved in 82 percent of the fall/winter months under TROA compared to 93 percent under current conditions. This 11-percent difference is a potential adverse effect. Lethal flows occur in 5 percent of the fall/winter months under TROA, compared to 3 percent under current conditions. Because this small difference in the frequency of lethal flows is not likely to have a significant effect on adult survival and recruitment from other reaches of the river, the moderate difference in the frequency of achieving preferred flows for brown trout in this reach is not considered a significant effect on the long-term survival of the brown trout population.

Spice: In the Spice reach, preferred flows for brown trout are achieved in 79 percent of the fall/winter months under TROA compared to 92 percent under current conditions. This 13-percent difference is a potential adverse effect. Lethal flows occur in 6 percent of the fall/winter months under TROA compared to 4 percent under current conditions. Because this small difference in the frequency of lethal flows is not likely to have a significant effect on adult survival and recruitment from other reaches of the river, the moderate difference in the frequency of achieving preferred flows for brown trout in this reach is not considered a significant effect on the long-term survival of the brown trout population.

Lockwood: In the Lockwood reach, preferred flows for brown trout are achieved in 79 of the fall/winter months under TROA compared to 87 percent under current conditions. This 8-percent difference is a potential adverse effect. Lethal flows occur in 8 percent of the fall/winter months under TROA compared 6 percent under current conditions. Because this small difference in the frequency of lethal flows is not likely to have a significant effect on adult survival and recruitment from other reaches of the river, the moderate difference in the frequency of achieving preferred flows for brown trout in this reach is not considered a significant effect on the long-term survival of the brown trout population.

Differences between TROA and No Action in the frequencies that preferred flows for brown trout are achieved are similar to the differences between TROA and current conditions. In most reaches of the Truckee River and its upper tributaries within the study area, under TROA, preferred flows for brown trout are achieved about as frequently as under No Action (differences of only a few percent). Such small differences do not constitute a significant effect.

The same beneficial effects would occur in October on Donner Creek when TROA is compared to No Action as when it is compared to current conditions.

The differences in the frequency that preferred flows for brown trout are achieved in the Truckee River from Little Truckee River to the Trophy reach and in the Oxbow, and Spice reaches between TROA and No Action are less than the differences between TROA and current conditions, and the difference between TROA and No Action both in the Truckee River between Donner Creek and in the Little Truckee River is only 1 percent. TROA would, therefore, have no significant adverse effects in these reaches when compared to No Action.

6. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur to brown trout in the Truckee River or its tributaries under any of the alternatives.

C. Frequency that Minimum Flows for Various Life Stages of Brown Trout from October through March are Sustained

1. Summary of Effects

Analysis of operations model results for the frequency that minimum flows for brown trout during the fall/winter months are sustained shows that, under TROA, a significant beneficial effect would occur in five reaches of the Truckee River and its tributaries (table 3.42). Significant adverse effects would occur in the Truckee River from the confluence of the Little Truckee River to Trophy under No Action and LWSA, when compared to current conditions.

Table 3.42—Summary of effects: frequency that minimum flows for brown trout are sustained (+ = significant beneficial effect, - = significant adverse effect)

<table>
<tr><th></th><th colspan="3">Compared to current conditions</th><th colspan="2">Compared to No Action</th></tr>
<tr><th>River reach/tributary</th><th>No Action</th><th>LWSA</th><th>TROA</th><th>LWSA</th><th>TROA</th></tr>
<tr><td>Truckee River from Lake Tahoe to Donner Creek</td><td colspan="2">No effect</td><td>+</td><td colspan="2">No effect</td></tr>
<tr><td>Truckee River from Donner Creek to Little Truckee River</td><td colspan="5">No effect</td></tr>
<tr><td>Truckee River from Little Truckee River to Trophy</td><td>-</td><td>-</td><td colspan="2">No effect</td><td>+</td></tr>
<tr><td>Trophy</td><td colspan="5" rowspan="5">No effect</td></tr>
<tr><td>Mayberry</td></tr>
<tr><td>Oxbow</td></tr>
<tr><td>Spice</td></tr>
<tr><td>Lockwood</td></tr>
<tr><td>Donner Creek (October only)[1]</td><td colspan="2">No effect</td><td>+</td><td>No effect</td><td>+</td></tr>
<tr><td>Prosser Creek</td><td colspan="5">No effect</td></tr>
<tr><td>Independence Creek</td><td colspan="2">No effect</td><td>+</td><td>No effect</td><td>+</td></tr>
<tr><td>Little Truckee River upstream of Stampede Reservoir[2]</td><td colspan="5">Not applicable</td></tr>
<tr><td>Little Truckee River downstream from Stampede Reservoir</td><td colspan="2">No effect</td><td>+</td><td>No effect</td><td>+</td></tr>
</table>

[1] California Dam Safety Requirements require that the gates at Donner Lake dam remain open from November 15 to April 15. October is the only full spawning month in which Donner releases can be controlled.
[2] No minimum flow is identified because there is no controlled-release facility for this reach.

2. Method of Analysis

The frequency that minimum flows for spawning, incubating, and rearing brown trout from October through March are sustained (as generated by the operations model) was analyzed. Qualifying years were those in which flow was between the specified minimum and maximum for the entire 6-month period.

3. Threshold of Significance

The same threshold of significance was used as for the first indicator of fish in the Truckee River and its tributaries.

4. Model Results

Table 3.43 presents operations model results for the frequency (percent of years) that minimum flows for various life stages of brown trout from October through March (fall/winter months) are sustained in the Truckee River and its tributaries.

Table 3.43—Frequency (percent of years) that minimum flows for brown trout from October through March are sustained

River reach/tributary	Current conditions	No Action	LWSA	TROA
Truckee River from Lake Tahoe to Donner Creek	15	14	14	22
Truckee River from Donner Creek to Little Truckee River	45	42	42	44
Truckee River from Little Truckee River to Trophy	22	17	16	23
Trophy	93	96	96	100
Mayberry	93	94	94	93
Oxbow	92	91	90	91
Spice	89	86	86	87
Lockwood	86	85	85	81
Donner Creek (October only)[1]	79	85	85	98
Prosser Creek	3	1	1	2
Independence Creek	3	3	3	32
Little Truckee River upstream of Stampede Reservoir[2]	Not applicable			
Little Truckee River downstream from Stampede Reservoir	9	6	6	26

[1] California Dam Safety Requirements require that the gates at Donner Lake dam remain open from November 15 to April 15. October is the only full spawning month in which Donner releases can be controlled.
[2] No minimum flow is identified because there is no controlled-release facility for this reach.

5. Evaluation of Effects

a. No Action

Under No Action, minimum flows for brown trout are sustained less frequently in the fall/winter months than under current conditions in the reach of the Truckee River from Little Truckee River to Trophy. Although difference in frequency is only 5 percent, it would result in a significant adverse effect because minimum flows are sustained infrequently in this reach; it represents a more than 20-percent change from current conditions. Reaches with no effect are not discussed.

b. LWSA

In the Truckee River from Little Truckee River to Trophy, under LSWA, minimum flows for brown trout in the fall/winter months are sustained as frequently as under No Action and less frequently than under current conditions. Because minimum flows are sustained infrequently, the 6-percent difference actually represents more than a 25-percent change from current conditions, which would be a significant adverse effect. Reaches with no effect are not discussed.

c. TROA

Under TROA, minimum flows for brown trout are sustained more frequently than under current conditions in two reaches of the Truckee River and three reaches of its tributaries. Reaches with no effect are not discussed.

> **Truckee River from Lake Tahoe to Donner Creek:** Under TROA, minimum flows for brown trout are sustained moderately (8 percent) more frequently than under No Action. Because minimum flows are sustained infrequently, the difference actually represents nearly a 60-percent change from No Action, which would reduce brown trout mortality and would be a significant beneficial effect under TROA. Under TROA, minimum flows for brown trout are sustained 7 percent more frequently than under current conditions. Because minimum flows are sustained infrequently, the difference actually represents nearly a 45-percent change from current conditions, which, again, would be a significant beneficial effect under TROA.
>
> **Truckee River from Little Truckee River to Trophy:** Under TROA, minimum flows for brown trout are sustained 5 percent more frequently than under No Action. Because minimum flows are sustained infrequently, the difference actually represents nearly a 35-percent change from No Action, which would be a significant beneficial effect under TROA. Under TROA, minimum flows for brown trout are sustained 1 percent more frequently than under current conditions, which would not be a significant beneficial effect.
>
> **Donner Creek:** California Dam Safety Requirements preclude storing water in Donner Lake from November 15 to April 15, which precludes the possibility of controlling releases. Therefore, the minimum flows analysis for Donner Lake

releases includes only the month of October. Minimum flows for brown trout are sustained 98 percent of years under TROA compared to 85 percent under No Action, which would be a significant beneficial effect. Under TROA, minimum flows for brown trout are sustained 19 percent more frequently than under current conditions, which would be a significant beneficial effect.

Independence Creek: Minimum flows for brown trout are sustained in 32 percent of years under TROA compared to 3 percent under No Action, which would be a significant beneficial effect. Under TROA, minimum flows for brown trout are sustained 10 times more frequently than under current conditions, which would be a significant beneficial effect.

Little Truckee River downstream from Stampede Reservoir: Under TROA, minimum flows for brown trout are sustained more than 4 times more frequently than under No Action, which would be a significant beneficial effect. Minimum flows for brown trout are sustained 3 times more frequently than under current conditions, which also would be a significant beneficial effect under TROA.

6. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under TROA. A significant beneficial effect to brown trout spawning, incubation, and rearing in two reaches of the Truckee River and in three of its tributaries would occur under TROA.

D. Frequency that Preferred Flows for Various Life Stages of Rainbow Trout from April through September are Achieved or Exceeded Without Exceeding Maximum Flows

1. Summary of Effects

Analysis of operations model results for the frequency that preferred flows for rainbow trout are achieved or exceeded without exceeding maximum flows shows that significant beneficial effects would occur under TROA in the Truckee River from Little Truckee River to the Trophy reach, in the Oxbow and Spice reaches, compared to current conditions, and in Donner, Prosser, and Independence Creeks. No significant effects would occur under No Action or LWSA. Table 3.44 summarizes these effects.

2. Method of Analysis

The frequency that preferred flows for rainbow trout are achieved or exceeded from April through September without exceeding maximum flows (as generated by the operations model) was analyzed. Average monthly flows from each month from April through September were tallied if they were equal to or greater than the preferred flow and equal to or less than the maximum flow (when specified) for rainbow trout spawning, incubation, and rearing.

Table 3.44—Summary of effects: frequency that preferred flows for rainbow trout are achieved or exceeded without exceeding maximum flows (+ = significant beneficial effect, - = significant adverse effect)

<table>
<tr><th rowspan="2">River reach/tributary</th><th colspan="3">Compared to current conditions</th><th colspan="2">Compared to No Action</th></tr>
<tr><th>No Action</th><th>LWSA</th><th>TROA</th><th>LWSA</th><th>TROA</th></tr>
<tr><td>Truckee River from Lake Tahoe to Donner Creek</td><td colspan="5" rowspan="2">No effect</td></tr>
<tr><td>Truckee River from Donner Creek to Little Truckee River</td></tr>
<tr><td>Truckee River from Little Truckee River to Trophy</td><td colspan="2">No effect</td><td>+</td><td>No effect</td><td>+</td></tr>
<tr><td>Trophy</td><td colspan="5" rowspan="2">No effect</td></tr>
<tr><td>Mayberry</td></tr>
<tr><td>Oxbow</td><td colspan="2" rowspan="2">No effect</td><td>+</td><td colspan="2" rowspan="2">No effect</td></tr>
<tr><td>Spice</td><td>+</td></tr>
<tr><td>Lockwood</td><td colspan="5">No effect</td></tr>
<tr><td>Donner Creek (October only)</td><td colspan="2" rowspan="3">No effect</td><td>+</td><td rowspan="3">No effect</td><td>+</td></tr>
<tr><td>Prosser Creek</td><td>+</td><td>+</td></tr>
<tr><td>Independence Creek</td><td>+</td><td>+</td></tr>
<tr><td>Little Truckee River upstream of Stampede Reservoir</td><td colspan="5" rowspan="2">No effect</td></tr>
<tr><td>Little Truckee River downstream from Stampede Reservoir</td></tr>
</table>

3. Threshold of Significance

The same threshold of significance was used as for the first indicator of fish in the Truckee River and its tributaries.

4. Model Results

Table 3.45 presents operations model results for the frequency (percent of months) that preferred flows for various stages of rainbow trout from April through September are achieved or exceeded without exceeding maximum flows (when specified) in the Truckee River and its tributaries.

5. Evaluation of Effects

a. No Action

Under No Action, preferred flows for rainbow trout are achieved 13 and 12 percent more frequently than under current conditions in the Oxbow and Spice reaches of the Truckee River, respectively. These greater flows should result in more successful spawning,

Table 3.45—Frequency (percent of months) that preferred flows for rainbow trout from April through September are achieved or exceeded without exceeding maximum flows (when specified)

River reach/tributary	Current conditions	No Action	LWSA	TROA
Truckee River from Lake Tahoe to Donner Creek	26	26	26	27
Truckee River from Donner Creek to Little Truckee River	28	29	29	27
Truckee River from Little Truckee River to Trophy	21	24	25	41
Trophy	96	96	96	97
Mayberry	95	96	96	97
Oxbow	82	95	95	96
Spice	82	94	94	96
Lockwood	80	75	75	74
Donner Creek (October only)	18	18	18	31
Prosser Creek	25	25	24	34
Independence Creek	29	29	29	37
Little Truckee River upstream of Stampede Reservoir	60	60	60	57
Little Truckee River downstream from Stampede Reservoir	26	25	25	29

incubation, and rearing of rainbow trout in these reaches and would be a significant beneficial effect under No Action. Many other reaches show identical flows or differences of a few percent. Such differences are too small to produce a predictable biological response and are unlikely to have a significant effect. Other than in the Oxbow and Spice reaches, the greatest difference is 5-percent less flows in the Lockwood reach. Because preferred flows already are achieved in 80 percent of months, this difference would be unlikely to have a significant adverse effect.

b. LWSA

Under LWSA, preferred flows for rainbow trout are achieved 13 and 12 percent more frequently than under No Action and current conditions, respectively. These greater flows should result in more successful spawning, incubation, and rearing of rainbow trout in these reaches and are a significant beneficial effect when LWSA is compared to current conditions. Compared to both No Action and current conditions, flows in reaches are identical or differ by only a few percent. Such differences are too small to produce a predictable biological response and are unlikely to have a significant effect. Other than in the Oxbow and Spice reaches, the greatest difference is 5-percent less frequent flows in the Lockwood reach than under current conditions. Because preferred flows already are achieved in 80 percent of months, this difference would be unlikely to have a significant adverse effect.

c. TROA

In the Truckee River from Little Truckee River to Trophy and in Donner, Prosser, and Independence Creeks, under TROA, preferred flows for rainbow trout are achieved moderately to substantially more frequently than under No Action. In the Oxbow and Spices reaches, under TROA, preferred flows also are achieved moderately more frequently than under current conditions. These differences are discussed by reach. Reaches with no effect are not discussed.

> **Truckee River from Little Truckee River to Trophy**: Under TROA, preferred flows for rainbow trout are achieved 17 percent more frequently than under No Action and 20 percent more frequently than under current conditions. Because preferred flows occur infrequently under No Action and current conditions, these differences represent a near doubling of the number of months in which preferred flows are achieved. More successful spawning, incubation, and rearing of rainbow trout should occur in this reach, which would be a significant beneficial effect under TROA.
>
> **Oxbow Reach:** Under TROA, preferred flows rainbow trout are achieved 21 percent more frequently than under No Action and 14 percent more frequently than under current conditions. The latter difference is potentially significant. Lethal flows occur in 2.8 percent of the spring/summer months under TROA compared to 4.5 percent under current conditions. The difference in achieving preferred flows, in combination with the small difference in the occurrence of lethal flows, would be significant beneficial effect under TROA.
>
> **Spice Reach:** Under TROA, preferred flows for rainbow trout are achieved 2 percent more frequently than under No Action. There would be no effect. Under TROA, preferred flows are achieved 14 percent more frequently than under current conditions; this substantial difference is potentially significant. Lethal flows occur in 3 percent of the spring/summer months under TROA, compared to 4 percent under current conditions. The difference in achieving preferred flows, in combination with the small difference in the occurrence of lethal flows, would be a significant beneficial effect under TROA.
>
> **Donner Creek:** Under TROA, preferred flows for rainbow trout are achieved 13 percent more frequently than under either No Action or current conditions. This is only a moderate difference, but its actual effect would be greater because preferred flows occur infrequently in this reach under No Action and current conditions. This difference should have a beneficial effect on spawning, incubation, and rearing of rainbow trout in this reach and would be a significant beneficial effect under TROA.
>
> **Prosser Creek:** Under TROA, preferred flows for rainbow trout are achieved 9 percent more frequently than under either No Action or current conditions. This is only a moderate difference, but its actual effect would be greater because preferred flows occur infrequently in this reach under No Action and current

conditions. This difference should have a beneficial effect on spawning, incubation, and rearing of rainbow trout in this reach and would be a significant beneficial effect under TROA.

Independence Creek: Under TROA, preferred flows for rainbow trout are achieved 8 percent more frequently than under No Action or current conditions. This is a moderate, but potentially adverse effect. Lethal flows occur in Independence Creek in 63 percent of the spring/summer months under No Action and in 60 percent of months under current conditions compared to 42 percent under TROA, or one-third less frequently. This difference should have a beneficial effect on rainbow trout spawning, incubation, and rearing and would be a significant beneficial effect under TROA.

6. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under any of the alternatives. A significant beneficial effect to rainbow trout spawning, incubation, and rearing in three reaches of the Truckee River and in three of its tributaries would occur under TROA.

E. Frequency that Minimum Flows for Various Life Stages of Rainbow Trout from April through September are Sustained

1. Summary of Effects

Analysis of operations model results for the frequency that minimum flows for rainbow trout are sustained shows that a significant beneficial effect would occur under TROA in the Truckee River downstream from Lake Tahoe to Donner Creek, in Prosser and Independence Creeks, and in the Little Truckee River downstream from Stampede Reservoir. No effect would occur under either No Action or LWSA. Table 3.46 summarizes these effects.

2. Method of Analysis

The frequency that minimum flows for spawning, incubating, and rearing rainbow trout from April through September are sustained (as generated by the operations model) was evaluated. Qualifying years were those in which flow was between the specified minimum and maximum for the entire 6-month period.

3. Threshold of Significance

The same threshold of significance was used as for the first indicator of fish in the Truckee River and its tributaries.

Table 3.46—Summary of effects: frequency that minimum flows for rainbow trout are sustained (+ = significant beneficial effect, - = significant adverse effect)

<table>
<tr><th rowspan="2">River reach/tributary</th><th colspan="3">Compared to current conditions</th><th colspan="2">Compared to No Action</th></tr>
<tr><th>No Action</th><th>LWSA</th><th>TROA</th><th>LWSA</th><th>TROA</th></tr>
<tr><td>Truckee River from Lake Tahoe to Donner Creek</td><td colspan="2">No effect</td><td>+</td><td>No effect</td><td>+</td></tr>
<tr><td>Truckee River from Donner Creek to Little Truckee River</td><td rowspan="7" colspan="5">No effect</td></tr>
<tr><td>Truckee River from Little Truckee River to Trophy</td></tr>
<tr><td>Trophy</td></tr>
<tr><td>Mayberry</td></tr>
<tr><td>Oxbow</td></tr>
<tr><td>Spice</td></tr>
<tr><td>Lockwood</td></tr>
<tr><td>Donner Creek (October only)</td><td colspan="5">No effect</td></tr>
<tr><td>Prosser Creek</td><td rowspan="2" colspan="2">No effect</td><td>+</td><td rowspan="2">No effect</td><td>+</td></tr>
<tr><td>Independence Creek</td><td>+</td><td>+</td></tr>
<tr><td>Little Truckee River upstream of Stampede Reservoir[1]</td><td colspan="5">Not applicable</td></tr>
<tr><td>Little Truckee River downstream from Stampede Reservoir</td><td colspan="2">No effect</td><td>+</td><td>No effect</td><td>+</td></tr>
</table>

[1] No minimum flow is identified because there is no controlled release facility for this reach.

4. Model Results

Table 3.47 presents operations model results for the frequency (percent of years) that minimum flows for rainbow trout are sustained from April through September without exceeding maximum flows (when specified) in the Truckee River and its tributaries.

5. Evaluation of Effects

a. No Action

Under No Action, minimum flows for rainbow trout are sustained almost as frequently as under current conditions (difference of no more than 1 percent). There would be no effect.

b. LWSA

Under LWSA, minimum flows for rainbow trout are sustained almost as frequently as under No Action or current conditions (differences of no more than 1 percent). There would be no effect.

Table 3.47—Frequency (percent of years) that minimum flows for rainbow trout from April through September are sustained

River reach/tributary	Current conditions	No Action	LWSA	TROA
Truckee River from Lake Tahoe to Donner Creek	2	2	2	27
Truckee River from Donner Creek to Little Truckee River	14	14	14	12
Truckee River from Little Truckee River to Trophy	1	1	1	1
Trophy	92	92	92	94
Mayberry	91	92	92	93
Oxbow	89	89	89	93
Spice	89	89	89	93
Lockwood	88	88	88	92
Donner Creek (October only)	0	0	0	0
Prosser Creek	1	1	1	11
Independence Creek	0	0	0	7
Little Truckee River upstream of Stampede Reservoir[1]	Not applicable			
Little Truckee River downstream from Stampede Reservoir	1	1	1	14

[1] No minimum flow is identified because there is no controlled release facility for this reach.

c. TROA

Under TROA, minimum flows for rainbow trout are sustained substantially more frequently than under either No Action or current conditions in the Lake Tahoe to Donner Creek reach of the Truckee River, in Prosser and Independence Creeks, and in the Little Truckee River downstream from Stampede Reservoir. These results are discussed by reach. Reaches with no effect are not discussed.

Truckee River from Lake Tahoe to Donner Creek: Under TROA, minimum flows for rainbow trout are sustained substantially more frequently in this reach than under No Action or current conditions: in 27 percent of years under TROA compared to only 2 percent under No Action and current conditions. This large difference would have a beneficial effect on spawning, incubation, and rearing of rainbow trout and would be a significant beneficial effect under TROA.

Prosser Creek: Under TROA, minimum flows for rainbow trout in Prosser Creek are sustained substantially more frequently than under No Action or current conditions: 11 percent of years under TROA compared to only 1 percent under No Action and current conditions. This large difference would have a beneficial effect on spawning, incubation, and rearing of rainbow trout, and would be a significant beneficial effect under TROA.

Independence Creek: Under TROA, minimum flows for rainbow trout in Independence are sustained substantially more frequently than under No Action or current conditions. Under both No Action and current conditions minimum flows are never sustained, compared to 14 percent under TROA. This large difference would have a beneficial effect on spawning, incubation, and rearing of rainbow trout and would be a significant beneficial effect under TROA.

Little Truckee River downstream from Stampede Reservoir: Under TROA, minimum flows for rainbow trout in this reach are sustained substantially more frequently than under No Action or current conditions. Under both No Action and current conditions, minimum flows are sustained in only 1 percent of years, compared to 14 percent under TROA. This large difference would have a beneficial effect on spawning, incubation, and rearing of rainbow trout and would be a significant beneficial effect under TROA.

6. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under any of the alternatives. A significant beneficial effect to rainbow trout spawning, incubation, and rearing would occur in three reaches of the Truckee River and in three of its tributaries under TROA.

F. Frequency of Flushing/Stranding Flows

1. Summary of Effects

Analysis of operations model results shows that flows that may strand fish or flush fish downstream in Prosser Creek and in the Little Truckee River downstream from Stampede Reservoir from October through March occur much less frequently under TROA, which would be a significant beneficial effect. Table 3.48 summarizes these effects.

Table 3.48—Summary of effects: frequency that flushing/stranding flows occur (+ = significant beneficial effect, - = significant adverse effect)

Tributary	Period	Compared to current conditions			Compared to No Action	
		No Action	LWSA	TROA	LWSA	TROA
Prosser Creek	Oct–Mar	+	+	+	No effect	+
	Apr–Sep	No effect				
Little Truckee River downstream from Stampede Reservoir	Oct–Mar	No effect		+	No effect	+
	Apr–Sep	No effect				

2. Method of Analysis

For this analysis, a flushing/stranding flow is two times or more greater than the preferred flow for any given reach. CDFG has identified Prosser Creek and the Little Truckee River downstream from Stampede Reservoir as having the greatest problems with large flushing flows. To determine the frequency of flushing/stranding flows, flows in Prosser Creek and the Little Truckee River downstream from Stampede Reservoir for all months (generated from the operations model) were analyzed.

3. Threshold of Significance

Prosser Creek and the Little Truckee River each has its own brown and rainbow trout habitat conditions and channel morphology that can dramatically influence the effects of changes in the frequency of flushing/stranding flows on fish populations. Quantification of long-term effects of flushing/stranding flows is confounded by recruitment from other adjacent reaches and on-stream reservoirs. An absolute threshold value above or below which an effect is demonstrably significant is not, therefore, biologically defensible.

Interpretations of differences in the frequency of flushing/stranding flows must be based on best professional judgment, taking into consideration not just the relative difference in the frequencies being compared but also the absolute value of those frequencies. Operations model results show that flushing/stranding flows occur in 15 to 53 percent of years. The greatest differences among the alternatives occur in the fall/winter months, when frequency decreases range between 6 and 13 percent of years on Prosser Creek and between 8 and 12 percent on the Little Truckee River downstream from Stampede Reservoir. Although the value ranges are similar on the two reaches, flushing/stranding flows on Prosser Creek occur only about half as frequently as on the Little Truckee River. For this reason, the same relative difference in frequency of flushing/stranding flows cannot be expected to affect the two reaches to the same degree.

4. Model Results

Table 3.49 presents operations model results for the frequency (percent of years) that flushing/stranding flows occur (i.e., average monthly flows are equal to or are greater than twice the preferred flows for the representative fish species for that month).

Table 3.49—Frequency (percent of years) that flushing/stranding flows (i.e., twice preferred flows or greater) occur

Tributary	Season	Current conditions	No Action	LWSA	TROA
Prosser Creek	Fall/winter	28	21	21	15
	Spring/summer	28	28	28	31
Little Truckee River downstream from Stampede Reservoir	Fall/winter	53	49	49	41
	Spring/summer	16	16	16	20

5. Evaluation of Effects

a. No Action

Under No Action, flushing/stranding flows occur moderately less (7 percent) often in Prosser Creek in the fall/winter months than under current conditions. Although this difference is only 7 percent, flushing/stranding flows actually occur substantially less often. There are no other effects.

b. LWSA

Under LWSA, flushing/stranding flows occur as frequently as under No Action. There would be no effect.

c. TROA

Under TROA, flushing/stranding flows occur moderately less often in both Prosser Creek and the Little Truckee River downstream from Stampede Reservoir in the fall/winter months than under No Action or current conditions. These tributaries are discussed individually. Tributaries with no effect are not discussed.

Under TROA, flushing flows in Prosser Creek and the Little Truckee River downstream from Stampede Reservoir in the spring/summer months occur only slightly more frequently than under No Action or current conditions; this would not be a significant effect because flushing/stranding flows occur infrequently and would occur less often on an annual basis under TROA than under No Action, LWSA, or current conditions.

> **Prosser Creek:** Under TROA, flushing/standing flows occur nearly 30 percent less frequently in the fall/winter months than under No Action, which would be a significant beneficial effect. Flushing/stranding flows occur in the fall/winter months in 15 percent of years under TROA, compared to 28 percent under current conditions. Because these flows occur relatively often, this difference would be a significant beneficial effect under TROA.
>
> **Little Truckee River downstream from Stampede Reservoir:** Under TROA, flushing/stranding flows in the fall/winter months occur in 41 percent of years compared to 49 percent under No Action and 53 percent under current conditions. Because fall/winter flushing/ stranding flows occur relatively frequently, in about half of the years, the moderate difference in frequency under TROA would be a significant beneficial effect under TROA. Under TROA, in the spring/summer months, flushing/stranding flows occur 4 percent more frequently than under No Action or current conditions. Because flushing/stranding flows occur infrequently, this would not be a significant effect on fish populations.

6. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under TROA. A significant beneficial effect would occur in Prosser Creek and the Little

Truckee River downstream from Stampede Reservoir in the fall/winter months under TROA because flushing/stranding flows would occur less frequently.

G. Frequency of Low Flows in Winter Months that Increase the Potential for Anchor Ice Formation

1. Summary of Effects

Analysis of operations model results shows that, under TROA, in Donner Creek and Independence Creek, low flows that increase the potential for formation of anchor ice occur substantially less often than under No Action and current conditions. The potential for formation of anchor ice would not be affected under LWSA or No Action (table 3.50).

Table 3.50—Summary of effects: frequency of low flows in winter months that increase the potential for anchor ice formation
(+ = significant beneficial effect, - = significant adverse effect)

<table>
<tr><th rowspan="2">River reach/tributary</th><th colspan="3">Compared to current conditions</th><th colspan="2">Compared to No Action</th></tr>
<tr><th>No Action</th><th>LWSA</th><th>TROA</th><th>LWSA</th><th>TROA</th></tr>
<tr><td>Truckee River from Lake Tahoe to Donner Creek</td><td colspan="5" rowspan="4">No effect</td></tr>
<tr><td>Truckee River from Donner Creek to Little Truckee River</td></tr>
<tr><td>Oxbow</td></tr>
<tr><td>Spice</td></tr>
<tr><td>Donner Creek</td><td colspan="2" rowspan="2">No effect</td><td>+</td><td rowspan="2">No effect</td><td>+</td></tr>
<tr><td>Independence Creek</td><td>+</td><td>+</td></tr>
</table>

2. Method of Analysis

The frequency of flows low enough to increase the potential for anchor ice formation from December through February (winter months), as generated by the operations model, was evaluated. Only reaches where icing is a concern were evaluated. Monthly flows were tallied if they were below minimum flows specified by CDFG and NDOW.

3. Threshold of Significance

Each reach has its own brown and rainbow trout habitat conditions and channel morphology that can dramatically influence the effects of changes in the frequency of low flows that could increase the potential for anchor ice formation on fish populations. Quantification of long-term effects of such flows is confounded by recruitment from other adjacent reaches and on-stream reservoirs. An absolute threshold value above or below which an effect is demonstrably significant, therefore, is not biologically defensible.

Interpretations of differences in the frequency of low flows that could increase the potential for anchor ice formation must be based on best professional judgment, taking into consideration not just the relative difference in the frequencies being compared but also the absolute value of those frequencies. Operations model results show that low-flow conditions conducive to anchor ice formation occur relatively rarely on the mainstem of the Truckee River, with very little difference among the alternatives. In all but two cases on Donner and Independence Creeks, there is 1 percent or no difference in the frequency of such conditions. The exceptions are so marked that the likelihood of their having a significant effect on fish populations is very high.

4. Model Results

Table 3.51 presents operations model results for the frequency (percent of years) of low flows in winter months that increase the potential for anchor ice formation in selected reaches of the Truckee River and tributaries.

Table 3.51—Frequency (percent of years) of low flows in winter months that increase the potential for anchor ice formation

River reach/tributary	Current conditions	No Action	LWSA	TROA
Truckee River from Lake Tahoe to Donner Creek	16	16	16	17
Truckee River from Donner Creek to the Little Truckee River	10	10	10	10
Oxbow	3	4	5	5
Spice	3	6	6	7
Donner Creek	12	12	12	2
Independence Creek	44	44	45	22

5. Evaluation of Effects

a. No Action

Under No Action, flows low enough to increase the potential for anchor ice formation occur about as frequently (difference as of 3 percent or less) as under current conditions. There would be no effect. Tributaries with no effect are not discussed.

b. LWSA

Under LWSA, flows low enough to increase the potential for anchor ice formation occur about as frequently as under No Action (differences of 1 percent or less) and as under current conditions (differences of 3 percent or less). There would be no effect. Tributaries with no effect are not discussed.

c. TROA

A significant beneficial effect would occur under TROA in Donner and Independence Creeks. The results for each of these tributaries are discussed. Tributaries with no effect are not discussed.

Donner Creek: Under TROA, flows low enough to increase the potential for anchor ice formation occur in only 2 percent of years, compared to 12 percent under both No Action and current conditions. Under TROA, therefore, fish within Donner Creek would experience substantially less mortality from icing conditions during winter, which would be a significant beneficial effect under TROA.

Independence Creek: Under TROA, flows low enough to increase the potential for icing conditions occur in 22 percent of years, compared to 44 percent under both No Action and current conditions. Under TROA, therefore, fish in Donner Creek would experience substantially less mortality from icing conditions during winter, which would be a significant beneficial effect under TROA.

6. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under any of the alternatives. A significant beneficial effect would occur under TROA because icing conditions would occur less frequently in Donner and Independence Creeks.

Fish in Lakes and Reservoirs

I. Affected Environment

Native and non-native fish species occur in all of the lakes and reservoirs of the Truckee River system and in Lahontan Reservoir. Table 3.52 lists fish species found in each reservoir. Table 3.37 summarizes the spawning requirements of selected fish species in the Truckee River basin.

Nine native fish species occur in the Truckee River system, and all can occur in lakes and reservoirs in the study area. Lahontan redside shiner, speckled dace, Tahoe sucker, and tui chub are the most widespread species. Two species (cui-ui and LCT), are federally listed as endangered and threatened, respectively, and the mountain sucker is a California Species of Concern. See "Endangered, Threatened, and Other Special Status Species."

Most freshwater fish are adaptable to various habitat types, but each species has environmental limits that define its distribution. Some species, such as Lahontan redside shiner, speckled dace, and Tahoe sucker, have greater tolerance to different environmental conditions and, thus, are generally more widespread and abundant. Other species, such as mountain whitefish and mountain sucker, have more restricted environmental limits.

All native species, except mountain whitefish, spawn in spring and early summer when water temperatures are optimum for the species, flows are high, and lakes and reservoirs are filling or full. Mountain whitefish spawn in October and November when water temperatures are cold, streamflows are low, and lakes and reservoirs are lower because of summer releases.

Non-native fish species have been introduced extensively throughout the Truckee and Carson River basins, and some occur in each lake and reservoir. Twenty-five non-native fish species are found in lakes and reservoirs in the system (table 3.52). In general, all the non-native salmonids (trout and salmon), except rainbow trout, spawn in the fall and winter, and all but lake trout spawn in the Truckee River or its tributaries. The remaining non-native fish spawn in spring or early summer. They generally spawn in the lakes and reservoirs, although some can spawn in tributaries with large pools of slow, warm water.

Large fluctuations in elevation and steep slopes associated with Prosser Creek, Stampede, and Boca Reservoirs are not conducive to shallow water spawning. Lake Tahoe, Donner, Independence, and Pyramid Lakes and Lahontan Reservoir provide the best shallow water fish spawning habitat in the area since these water bodies may not have as many fluctuations in water elevation nor do they have as steep of slopes as the other reservoirs under operation.

Adequate water storage in lakes and reservoirs is important for fish survival. Primary concerns associated with low water volumes in the Truckee River basin reservoirs are increased temperatures and lack of dissolved oxygen. Higher temperatures and lower DO levels can lead to fish stress and kills.

Table 3.52—Occurrence and abundance of fish in lakes and reservoirs in the study area[1,2]

Species	Lake Tahoe	Donner Lake	Martis Creek Reservoir	Prosser Creek Reservoir	Independence Lake	Stampede Reservoir	Boca Reservoir	Pyramid Lake	Lahontan Reservoir
Native fish									
Lahontan cutthroat trout	none	none	U	none	C	none	none	C-P	none
Mountain whitefish	U	U	none	U	C	U	none	none	none
Paiute sculpin	C	U	none	U	C	U	U	none	none
Lahontan redside shiner	C	C	U	C	C	C	C	C	U
Speckled dace	C	C	U	C	C	C	C	C	U
Lahontan tui chub	C	C	none	U	C	C	C	C	U
Tahoe sucker	C	C	C	C	C	C	C	C	U
Mountain sucker	U	U	none	U	none	U	none	none	U
Cui-ui	none	none	none	none	none	none	none	C	none
Non-native fish[3]									
Rainbow trout	C-P[4]	C-P[4]	C	C-P[4]	none	C-P[4]	C-P[4]	none	none
Brown trout	C-P[4]	C	C	C	U	C-P[4]	C-P[4]	none	none
Brook trout	U	none	none	none	C	none	none	none	none
Mackinaw lake trout	C	C-P	none	none	none	C-P	none	none	none
Kokanee salmon	C-P	U-P	none	none	C	C-P	C-P	none	none
Sacramento perch	none	none	none	none	none	none	none	U	C
Walleye	none	none	none	none	none	none	none	none	C-P
White bass	none	none	none	none	none	none	none	none	C-P
Largemouth bass	U	none	none	none	none	none	none	none	C
Smallmouth bass	U	none	U	none	none	C	U	none	none
Spotted bass	none	none	none	none	none	none	none	none	U
Green sunfish	none	none	U	none	none	U	U	none	C
Wipers	none	none	none	none	none	none	none	none	C-P
Channel catfish	none	none	none	none	none	none	none	none	C
White catfish	none	none	none	none	none	none	none	none	C
Yellow perch	none	none	none	none	none	none	none	none	U
White crappie	U	none	none	none	none	none	none	none	C

Table 3.52—Abundance and use of lakes and reservoirs by fish of the Truckee River system – continued

Species	Lake Tahoe	Donner Lake	Martis Creek Reservoir	Prosser Creek Reservoir	Independence Lake	Stampede Reservoir	Boca Reservoir	Pyramid Lake	Lahontan Reservoir
Non-native fish – continued									
Black crappie	none	none	none	none	none	none	none	none	C
Sacramento blackfish	none	none	none	none	none	none	none	none	C
Carp	none	none	none	none	none	none	none	none	C
Goldfish	none	none	none	none	none	none	none	none	U
Fathead minnow	none	none	none	none	none	none	none	none	U
Golden shiner	U	none	none	none	none	none	none	none	none
Bullhead	U	none	none	none	none	none	none	none	C
Mosquitofish	none	none	none	none	none	none	none	none	C

[1] Sources: Coffin, 2003; Hiscox, 2003; Tisdale, 2003; Solberger, 2003.
[2] C = common; U = uncommon; P = planted (to maintain quality of recreational fishery).
[3] Many non-native species have become naturalized and no longer need to be planted to maintain population abundance.
[4] Reproducing populations may also be present.

Extensive algal blooms may occur in Lahontan Reservoir when water storage is low. Fish kills sometimes occur in summer when water elevations are low and blooms of the blue-green alga, *Aphanizomenon flos-aquae*, occur (NDOW, 1992a). When green and blue-green algae are active, they produce oxygen; when they decompose, they consume oxygen. Rapid decomposition, which may occur following large blooms, may adversely affect invertebrates and fish and lead to fish kills by reducing the amount of dissolved oxygen available for respiration. Fish kills at Lahontan Reservoir may also have resulted from the toxins produced by *Aphanizomenon* and not oxygen depletion. However, blooms may not develop if wind produces wave action on the open water or if mechanical aeration systems are activated.

II. Environmental Consequences

A. Introduction

To evaluate the effects of changes in reservoir and lake storage on resident fish, the following two indicators were selected:

- Fish survival based on minimum storage thresholds
- Spring/summer shallow water fish spawning habitat

B. Summary of Effects

Table 3.53 summarizes the effects on fish in lakes and reservoirs.

Table 3.53—Summary of effects: fish in lakes and reservoirs
(+ = significant beneficial effect, - = significant adverse effect)

<table>
<tr><th rowspan="2">Lake/reservoir</th><th colspan="3">Compared to current conditions</th><th colspan="2">Compared to No Action</th></tr>
<tr><th>No Action</th><th>LWSA</th><th>TROA</th><th>LWSA</th><th>TROA</th></tr>
<tr><th colspan="6">Fish survival</th></tr>
<tr><td>Prosser Creek</td><td colspan="3">+</td><td rowspan="3">No effect</td><td rowspan="3">+</td></tr>
<tr><td>Stampede</td><td colspan="2" rowspan="2">No effect</td><td rowspan="2">+</td></tr>
<tr><td>Boca</td></tr>
<tr><td>Lahontan</td><td colspan="5">No effect</td></tr>
<tr><th colspan="6">Spring/summer shallow water fish spawning habitat</th></tr>
<tr><td>Tahoe</td><td colspan="5" rowspan="5">No effect</td></tr>
<tr><td>Donner</td></tr>
<tr><td>Independence</td></tr>
<tr><td>Pyramid</td></tr>
<tr><td>Lahontan</td></tr>
</table>

C. Fish Survival Based on Minimum Storage Thresholds

1. Method of Analysis

For the fish survival analysis, minimum storage thresholds (thresholds) were assigned and analyzed for Prosser Creek, Stampede, Boca, and Lahontan Reservoirs. CDFG and NDOW have recommended thresholds for these reservoirs to maintain fisheries, water quality, and aquatic productivity. The conservation pool threshold in Lahontan Reservoir, agreed to by TCID in 1992, is recommended to minimize algal blooms. The established thresholds are as follows:

- Prosser Creek Reservoir: 5,000 acre-feet minimum
- Stampede Reservoir: 15,000 acre-feet minimum
- Boca Reservoir: 10,000 acre-feet minimum
- Lahontan Reservoir: 4,000 acre-feet minimum

The analysis for fish survival evaluated the probability (frequency) that storage in these four reservoirs is below thresholds at least once during the year, as shown by operations model results. The analysis assumes that the greater the storage throughout the year, the greater the fish productivity, and that fish survival is likely to be adversely affected the more frequently storage is below these thresholds.

2. Threshold of Significance

Fish populations at Prosser Creek, Stampede, Boca, and Lahontan Reservoirs could be adversely affected if reservoir storage were to fall below the thresholds recommended to maintain fish populations, water quality, and aquatic productivity at a sufficient frequency and magnitude, relative to current conditions or No Action, to significantly affect fish survival. The significance of differences was based on best professional judgment.

3. Model Results

Table 3.54 presents operations model results for the frequency (percent of years) that storage in the reservoirs is below the recommended thresholds.

Table 3.54—Frequency (percent of years) that storage in reservoirs is below the recommended thresholds

Lake/reservoir	Current conditions	No Action	LWSA	TROA
Prosser Creek	41	20	20	11
Stampede	15	11	14	2
Boca	90	88	89	55
Lahontan	16	16	16	16

4. Evaluation of Effects

a. No Action

(1) Prosser Creek Reservoir

Operations model results show that, under No Action, Prosser Creek Reservoir is below the threshold in about half as many years as under current conditions. As a result, under No Action, fish mortality would be substantially less than under current conditions, which would be significant beneficial effect.

(2) Stampede Reservoir

Under No Action, Stampede Reservoir is below the threshold in only 4 percent fewer years than under current conditions. There would be no effect.

(3) Boca Reservoir

Under No Action, Boca Reservoir is below the threshold in 2 percent fewer years than under current conditions. There would be no effect.

(4) Lahontan Reservoir
Under No Action, Lahontan Reservoir is below the threshold as frequently as under current conditions. There would be no effect.

b. LWSA

(1) Prosser Creek Reservoir
Under LWSA, Prosser Creek Reservoir is below the threshold as frequently as under No Action. There would be no effect. The reservoir is below the threshold in about half as many years as under current conditions, which would be significant beneficial effect under LWSA when compared to current conditions.

(2) Stampede Reservoir
Under LWSA, Stampede Reservoir is below the threshold in only 3 percent more years than under No Action. There would be no effect. Under LWSA, the reservoir is below the threshold about as frequently as under current conditions (difference of only 1 percent). This small difference would not have a significant effect.

(3) Boca Reservoir
Under LWSA, Boca Reservoir is below the threshold about as frequently as under No Action or current conditions (differences of 1 percent). These small differences would not have a significant effect.

(4) Lahontan Reservoir
Under LWSA, Lahontan Reservoir is below the threshold as frequently as under No Action or current conditions. There would be no effect.

c. TROA

(1) Prosser Creek Reservoir
Under TROA, Prosser Creek Reservoir is below the threshold in about half as many years as under No Action and in nearly 30 percent fewer years than under current conditions. As a result, fish mortality would be substantially less under TROA, which would be a significant beneficial effect.

(2) Stampede Reservoir
Under TROA, Stampede Reservoir is below the threshold in 9 percent fewer years than under No Action and in nearly 13 percent fewer years than under current conditions. As a result, fish mortality would be substantially less under TROA, which would be a significant beneficial effect.

(3) Boca Reservoir

Under TROA, Boca Reservoir is below the threshold in 33 percent fewer years than under No Action and in 35 percent fewer years than under current conditions. As a result, fish mortality would be substantially less under TROA, which would be a significant beneficial effect.

(4) Lahontan Reservoir

Under TROA, Lahontan Reservoir is below the threshold as frequently as under No Action or current conditions. There would be no effect.

5. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under any of the alternatives. A significant beneficial effect would occur under TROA because storage in Prosser Creek, Stampede, and Boca Reservoirs would fall below the thresholds substantially less often than under No Action or current conditions.

D. Spring/Summer Shallow Water Fish Spawning Habitat

1. Method of Analysis

The shallow water fish spawning habitat analysis compared the amount of available fish spawning habitat under current conditions, No Action, LWSA, and TROA based on operations model results. Spring and summer shallow water fish spawning habitat was measured by the average acres of shallow (i.e., less than 1 meter (3.28 feet) deep) water habitat in Lake Tahoe and Donner and Independence Lakes in June in wet, median, and dry hydrologic conditions. The use of wet, median, and dry hydrologic conditions is not applicable in analysis of Pyramid Lake because it is a terminal lake. The total area in wet, median, and dry hydrologic conditions, therefore, does not correlate with these hydrologic conditions due to the general trend for the water elevation of Pyramid Lake to increase from current conditions under all alternatives. The Pyramid Lake analysis uses the average total acres of shallow water habitat in June over the modeled 100-year period. June was chosen as a representative month for fish that spawn in spring and summer in the basin because, although the spawning season for the various fish species may cover different time periods in the spring and summer, the majority of fish spawn in June.

A separate analysis was conducted for spring and summer fish spawning at Lahontan Reservoir. NDOW recommends a minimum storage threshold of 160,000 acre-feet at Lahontan Reservoir in May and June to benefit fish spawning. Below this threshold, rocky substrate important for spawning and cover for young fish becomes limited (Reclamation, 1986; Sevon, 1993). The analysis for spring and summer fish spawning at Lahontan Reservoir evaluated the frequency that the storage is below this threshold in May and June under current conditions and the alternatives.

2. Threshold of Significance

An effect on fish populations at Lake Tahoe and Donner, Independence, and Pyramid Lakes were considered significant if a change in shallow water habitat of 15 percent or more were to occur in June, as shown by operations model results. An effect on fish populations at Lahontan Reservoir was considered significant if storage were to fall below the recommended threshold (160,000 acre-feet) 15 percent or more frequently in May and June, as shown by operations model results.

3. Model Results

Table 3.55 presents operation model results for the average total area in acres of shallow water fish spawning habitat in June in wet, median, and dry hydrologic conditions at Lake Tahoe and Donner and Independence Lakes. Table 3.56 presents operations model results for the average total area of shallow water fish spawning habitat in June at Pyramid Lake. Table 3.57 presents operations model results for the frequency that Lahontan Reservoir is below 160,000 acre-feet in May and June.

Table 3.55—Average total area (acres) of shallow water fish spawning habitat in June in wet, median, and dry hydrologic conditions at Lake Tahoe and Donner and Independence Lakes

Lake	Hydrologic condition	Current conditions	No Action	LWSA	TROA
Tahoe	Wet	1,301	1,301	1,301	1,301
	Median	1,292	1,291	1,291	1,292
	Dry	715	715	715	722
Donner	Wet	38	38	38	38
	Median	38	38	38	38
	Dry	33	33	33	33
Independence	Wet	29	29	29	29
	Median	29	29	29	29
	Dry	25	26	26	24

4. Evaluation of Effects

a. No Action

(1) Lake Tahoe

Operations model results show that the average total area of shallow water fish spawning habitat at Lake Tahoe under No Action is about the same as under current conditions in all three hydrologic conditions (maximum difference of 1 acre). There would be no significant effect.

Table 3.56—Average total area (acres) of shallow water fish spawning habitat in June at Pyramid Lake

Current conditions	No Action	LWSA	TROA
1,675	1,663	1,664	1,666

Table 3.57—Frequency that Lahontan Reservoir is below 160,000 acre-feet in May and June

Current conditions	No Action	LWSA	TROA
16	18	18	20

(2) Donner Lake

The average total area of shallow water fish spawning habitat at Donner Lake under No Action is the same as under current conditions in all three hydrologic conditions. There would be no effect.

(3) Independence Lake

The average total area of shallow water fish spawning habitat at Independence Lake under No Action is about the same as under current conditions in all three hydrologic conditions (maximum difference of 1 acre). There would be no significant effect.

(4) Pyramid Lake

The average total area of shallow water fish spawning habitat at Pyramid Lake under No Action is about the same as under current conditions (difference of less than 1 percent) in all three hydrologic conditions. There would be no significant effect.

(5) Lahontan Reservoir

Under No Action, Lahontan Reservoir is below 160,000 acre-feet 2 percent more frequently than under current conditions. There would be no significant effect.

b. LWSA

(1) Lake Tahoe

The average total area of shallow water fish spawning habitat at Lake Tahoe under LWSA is the same as under No Action in all three hydrologic conditions and is about the same as under current conditions (difference of 1 acre in median hydrologic conditions). There would be no significant effect.

(2) Donner Lake

The average total area of shallow water fish spawning habitat at Donner Lake under LWSA is the same as under No Action or current conditions in all three hydrologic conditions. There would be no effect.

(3) Independence Lake

The average total area of shallow water fish spawning habitat at Independence Lake under LWSA is the same as under No Action in all hydrologic conditions and is about the same as under current conditions (difference of 1 acre in dry hydrologic conditions). There would be no effect.

(4) Pyramid Lake

The average total area of shallow water fish spawning habitat at Pyramid Lake under LWSA is about the same as under No Action or current conditions (differences of less than 1 percent). There would be no effect.

(5) Lahontan Reservoir

Under LWSA, Lahontan Reservoir is below 160,000 acre-feet as frequently as under No Action and 2 percent more frequently than under current conditions. There would be no significant effect.

c. TROA

(1) Lake Tahoe

Under TROA, the average total area of shallow water fish spawning habitat at Lake Tahoe is the same as under No Action or current conditions in wet hydrologic conditions and is about the same in median and dry hydrologic conditions (differences of less than 1 percent). There would be no effect.

(2) Donner Lake

Under TROA, the average total area of shallow water fish spawning habitat at Lake Tahoe is the same as under No Action or current conditions in any hydrologic condition. There would be no effect.

(3) Independence Lake

The average total area of shallow water fish spawning habitat at Independence Lake is the same under TROA and No Action in wet and median hydrologic conditions, and it differs by less than 8 percent in dry hydrologic conditions. It is the same as under current conditions, except in dry hydrologic conditions (difference of only 1 acre). There would be no effect. TROA would allow for water exchange among reservoirs and provide greater flexibility in the management of Independence Lake to limit or increase fish spawning habitat.

(4) Pyramid Lake

The average total area of shallow water fish spawning habitat at Pyramid Lake under TROA is less than 1 percent less than under No Action or current conditions. There would be no effect.

(5) Lahontan Reservoir

Under TROA, Lahontan Reservoir is below 160,000 acre-feet 2 percent more frequently than under No Action and 4 percent more frequently than under current conditions. These small differences are not enough to pose a threat to fish populations in Lahontan Reservoir. Most fish species that spawn in Lahontan Reservoir are introduced, many are planted, and none are imperiled. No significant effect, therefore, would occur.

5. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under any of the alternatives.

Waterfowl and Shorebirds

I. Affected Environment

Waterfowl and shorebirds that use lakes and reservoirs in the Truckee River basin are listed in the Biological Resources Appendix. In general, habitat at reservoirs is of lower quality and provides less plant and animal food for water birds than do natural (i.e., unregulated) lakes and ponds; this may be because fluctuating elevations inhibit the establishment and development of shoreline vegetation that many birds require (Beedy and Granholm, 1985). Lake Tahoe, Pyramid Lake, Lahontan Reservoir, and, to a lesser extent, Stampede Reservoir, provide large quantities of more stable, higher quality habitat that supports the largest populations of waterfowl in the study area. Stampede and Lahontan Reservoirs and Pyramid Lake also have islands where many bird species nest. Donner and Independence Lakes and Prosser Creek and Boca Reservoirs provide relatively limited habitat because of their small size, high recreational use, or widely fluctuating water elevations. During summer months, water bird use at many of the lakes and reservoirs is limited due to human recreation activities.

Common water bird species at Lake Tahoe include Canada geese, California gulls, mallards, and mergansers. The lake is used by various migrating waterfowl and shorebirds. The number of nesting birds has greatly decreased with development of the shoreline (Orr and Moffitt, 1971).

Stampede Reservoir provides foraging habitat for migrating waterfowl. Canada goose is the primary island nesting species at Stampede Reservoir; nesting occurs from March through May.

Lahontan Reservoir is used by dabbling ducks, especially during the fall, and is an important nesting and feeding area for Canada geese (Saake, 1994). American white pelicans also use Lahontan Reservoir during the spring, particularly when lakes and ponds at Stillwater National Wildlife Refuge and other Lahontan Valley wetlands are reduced during drought years. Waterbird nesting occurs on Gull and Evans Islands in Lahontan Reservoir. Colonial nesting species, such as California and ring-billed gulls; double-crested cormorant; great blue heron; snowy, great, and cattle egrets; and black-crowned night heron, nest on these islands from March through July (Neel, 1995).

Of the 51 water bird species that occur at Pyramid Lake, 29 species (excluding shorebirds) potentially breed at or near the lake; 10 of these species are winter visitors, and 12 are transients during fall and spring migration (Biological Resources Appendix). Waterfowl use at Pyramid Lake is greatest during the fall and winter. Pyramid Lake is especially important waterfowl habitat in drought years when other wetlands are dry. Anaho Island in Lake Pyramid provides nesting habitat for many bird species. The northern end of Pyramid Lake, which provides shallow feeding areas and is less disturbed by recreationists, and the southern end near the mouth of the Truckee River, are the most important feeding areas for waterfowl.

Table 3.58 presents 2003 survey data for wintering waterfowl within the four counties that include lakes and reservoirs in the study area in Nevada. The numbers included in this table are likely higher than the actual number of waterfowl using the major water bodies within the study area because the survey was county-wide; data for two wildlife management areas within the four counties but not part of this analysis are not included in the numbers shown in the table.

Table 3.58—Number of waterfowl counted during 2003 FWS mid-winter inventories of all major wetlands in Douglas County (Lake Tahoe), Lyon County (Lahontan Reservoir), Churchill County (Lahontan Reservoir), and Washoe County (Lake Tahoe and Pyramid Lake), Nevada

	Douglas Co.	Lyon Co.	Churchill Co.[1]	Washoe Co.[2]	Total
Dabbling ducks	1,020	1,645	18,436	6,114	27,215
Diving ducks	110	497	4,946	2,493	8,046
Geese	1,530	2,250	1,650	8,964	14,394
Swans	14	41	180	410	645
Coots	130	1,170	7,180	2,217	10,697
Total	2,804	5,603	32,392	20,198	60,997

[1] Churchill County data do not include waterfowl inventoried at Stillwater WMA.
[2] Washoe County data do not include waterfowl inventoried at Scripps Management Area.

II. Environmental Consequences

A. Introduction

Modifying operations of Truckee River reservoirs could affect lake and reservoir elevations. In turn, reservoir elevations could affect waterfowl, shorebirds, and island-nesting birds in the study area. This analysis evaluated the effects of changes in water elevations on these bird guilds using following indicators:

- Waterfowl and shorebird shallow water foraging habitat
- Island bird nest predation and inundation

B. Summary of Effects

At Stampede Reservoir, analysis of operations model results shows that, under TROA, predator access to islands on which birds nest occurs less frequently than under

No Action or current conditions (table 3.59). This beneficial effect would be offset, however, by the greater probability that the island would be inundated. The difference is not significant compared to No Action, but would have an adverse effect on the potential for local nesting success by Canada geese when compared to current conditions. This local adverse effect is not significant to the overall regional population of Canada geese and would require no mitigation.

Table 3.59—Summary of effects: waterfowl and shorebirds (+ = significant beneficial effect, * = nonsignificant adverse effect)

<table>
<tr><th rowspan="2">Lake/reservoir</th><th colspan="3">Compared to current conditions</th><th colspan="2">Compared to No Action</th></tr>
<tr><th>No Action</th><th>LWSA</th><th>TROA</th><th>LWSA</th><th>TROA</th></tr>
<tr><td colspan="6">Waterfowl and shorebird shallow water foraging habitat</td></tr>
<tr><td>Tahoe</td><td colspan="5">No effect</td></tr>
<tr><td>Stampede</td><td colspan="3">No effect</td><td>No effect</td><td>+</td></tr>
<tr><td>Pyramid</td><td colspan="5" rowspan="2">No effect</td></tr>
<tr><td>Lahontan</td></tr>
<tr><td colspan="6">Island bird nest predation and inundation</td></tr>
<tr><td>Stampede</td><td colspan="2">No effect</td><td>*</td><td colspan="2">No effect</td></tr>
<tr><td>Lahontan</td><td colspan="5">No effect</td></tr>
</table>

At Lahontan Reservoir, predator access to islands on which birds nest occurs slightly more frequently under TROA, but the difference is too small to constitute a significant adverse effect.

C. Waterfowl and Shorebird Shallow Water Foraging Habitat

1. Method of Analysis

Shallow water foraging habitat for waterfowl and shorebirds, for the purpose of this analysis, is the total area of water less than 18 inches deep along the shoreline of lakes and reservoirs. This water depth was selected because the foraging habitat of most waterfowl and shorebird species is not deeper than 18 inches (Jasmer, 2000; Biological Resources Appendix). Lake Tahoe, Stampede and Lahontan Reservoirs, and Pyramid Lake are the only lakes and reservoirs in the study area frequently used by large numbers of water birds, so only these lakes and reservoirs were evaluated. The amount of year-round foraging habitat was estimated for Lake Tahoe and Lahontan Reservoir, given their use by wintering, migrating, and breeding waterfowl. The amount of foraging habitat from February through October was estimated for Stampede Reservoir, because it is primarily used by migrating and, to a lesser degree, breeding waterfowl. The amount of foraging habitat for Pyramid Lake from September through January, the period of use by wintering waterfowl, was evaluated.

Operations model results were used to measure the total area of waterfowl and shorebird shallow water foraging habitat available in wet, median, and dry hydrologic conditions at Lake Tahoe and Stampede and Lahontan Reservoirs by averaging the number of acres of water less than 18 inches during the period of use. The use in wet, median, and dry hydrologic conditions is not applicable in analysis of Pyramid Lake because it is a terminal lake. The total area in wet, median, and dry hydrologic conditions, therefore, does not correlate with these hydrologic conditions because of the general trend for the elevation of Pyramid Lake to increase from current conditions under all alternatives. The Pyramid Lake analysis used the average total acres of shallow water habitat less than 18 inches deep over the modeled 100-year period.

2. Threshold of Significance

A change in the average total area of shallow water foraging habitat of 15 percent or greater during the period of use at Lake Tahoe, Pyramid Lake, and Lahontan and Stampede Reservoirs was considered significant. This assessment was based on the output of the operations model and best professional judgment.

3. Model Results

Table 3.60 presents operations model results for shallow water foraging habitat at Lake Tahoe and Stampede and Lahontan Reservoirs. Table 3.61 presents operations model results for shallow water foraging habitat at Pyramid Lake.

Table 3.60—Average total area (acres) of shallow water foraging habitat for waterfowl and shorebirds in wet, median, and dry hydrologic conditions during the period of use at Lake Tahoe and Stampede and Lahontan Reservoirs

Lake/reservoir	Period of use	Hydrologic condition	Current conditions	No Action	LWSA	TROA
Tahoe	Year-round	Wet	774	774	774	790
		Median	593	588	587	617
		Dry	326	326	326	326
Stampede	February-October	Wet	48	48	48	48
		Median	43	43	43	43
		Dry	23	26	26	41
Lahontan	Year-round	Wet	997	1,012	1,012	1,012
		Median	359	351	351	354
		Dry	217	201	200	201

Table 3.61—Average total area (acres) of shallow water foraging habitat for waterfowl and shorebirds from September through January at Pyramid Lake

Current conditions	No Action	LWSA	TROA
765	759	757	764

4. Evaluation of Effects

a. No Action

Operations model results show that, with a few exceptions, under No Action, less shallow water foraging is available habitat than under current conditions. The differences are less than 2 percent, except in dry hydrologic conditions, when 7 percent less habitat is available than under current conditions. None of the differences would have a significant effect.

b. LWSA

In most cases, under LWSA, less shallow water foraging habitat is available than under No Action or current conditions. The differences are always 1 percent or less. Such small differences would not constitute a significant effect.

The differences between LWSA and current conditions are also small. All differences are less than 2 percent, except in dry hydrologic conditions, when LWSA differs from current conditions by 8 percent. None of the differences would constitute a significant effect.

c. TROA

Operation model results show that, under TROA, the same amount or more shallow water foraging habitat is available as under No Action at all lakes and reservoirs. Most differences are less than 5 percent, too small to be considered significant. Under TROA, at Stampede Reservoir in dry hydrologic conditions, however, nearly 60 percent more shallow water foraging habitat is available than under No Action, which would be significant beneficial effect.

Under TROA, the same amount or more shallow water foraging habitat is available as under current conditions at most lakes and reservoirs in most hydrologic conditions. All differences are less than 5 percent, too small to be considered significant. At Stampede Reservoir in dry hydrologic conditions, however, nearly 80 percent more shallow water habitat is available than under current conditions, which would be significant beneficial effect.

Under TROA, less habitat is available than under current conditions at Lahontan Reservoir in median and dry hydrologic conditions; the differences are less than 2 and 8 percent, respectively, and do not constitute a significant effect. One fewer acre is available at Pyramid Lake than under No Action; this also would not be a significant effect.

The greatest effect on shallow water foraging habitat occurs in dry hydrologic conditions at Lahontan Reservoir, where up to 8 percent less habitat is available under No Action, LWSA, and TROA than under current conditions. Such small and infrequent differences in habitat would not be significant because they are unlikely to affect populations of waterfowl and shorebirds over the long-term. Although such habitat decreases may affect local bird populations in dry periods, the populations can be expected to rebound as hydrologic conditions change and the amount of habitat increases.

5. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under any of the alternatives. A significant beneficial effect would occur under TROA because more shallow water foraging habitat for waterfowl and shorebirds would be available at Stampede Reservoir in dry hydrologic conditions.

D. Island Bird Nest Predation and Inundation

1. Method of Analysis

Fluctuating lake and reservoir elevations can impair breeding success of birds. Lower elevations may allow predator access to nesting islands, while higher elevations may inundates nests. Contour intervals were used to estimate the water elevation at which a landbridge could make water bird nesting islands accessible to mainland predators. Getz and Smith (1989) recommend a distance of approximately 200 to 500 feet between an island and mainland and minimum water depths of 2 to 3.5 feet to reduce predation losses from canines. The island in Stampede Reservoir and the two islands in Lahontan Reservoir are accessible to mainland predators at elevations lower than 5880, 4142, and 4127 feet, respectively. Anaho Island in Pyramid Lake could be accessed by predators if the elevation were to drop below 3795 feet. No other lakes or reservoirs in the system have islands that could be accessed by mainland predators. The island in Stampede Reservoir becomes inundated above elevation 5940 feet, thereby eliminating waterfowl nesting on the island. Gull and Evans Islands in Lahontan Reservoir are above the spillway elevation of Lahontan Dam, and inundation of Anaho Island is highly unlikely because of its height above the current elevation of Pyramid Lake.

Operations model results showing surface water elevation were used to determine the frequency (percent of years) that predator access could occur during at least 1 month in the nesting season at islands in Stampede and Lahontan Reservoirs and Pyramid Lake. These data were also used to examine the frequency (percent of years) that the island in Stampede Reservoir could be inundated during at least 1 month in the nesting season.

Operations model results show that Pyramid Lake never is below the landbridge threshold elevation of 3795 feet under current conditions or the alternatives; therefore, there is no further discussion of predator access to Anaho Island.

If predation or inundation were to occur early in the nesting season, island nesting birds could re-nest if conditions improve later in the nesting season. The potential for re-nesting is unknown and is not considered in this analysis.

2. Threshold of Significance

An analysis of historical lake elevation data from 1939 to 1996 shows that Gull Island, the main nesting island in Lahontan Reservoir, has been landbridged in 26 percent of the years during the gull nesting season. Evans Island, the smaller island where a fewer bird species nest, has been landbridged in 7 percent of these years. Despite past landbridging, island nesting birds continue to breed successfully at Lahontan Reservoir. A significant effect could potentially occur if, based on operations model results, there is a change in the frequency that predator access to island nests during the nesting season (March through July). The significance of any effect was based on best professional judgment in considering the results of the operations model.

A significant effect could occur at Stampede Reservoir if operations model results show a change in the frequency that access by mammalian predators to, or inundation of, the island at Stampede Reservoir during the Canada geese nesting season (March through May). The significance of any effect was based on best professional judgment in considering the results of the operations model.

3. Model Results

Table 3.62 presents operations model results for the frequency (percent of years) of predator access to nesting islands in Stampede and Lahontan Reservoirs. Table 3.63 presents operations model results for the frequency (percent of years) of inundation of island nests at Stampede Reservoir.

Table 3.62—Frequency (percent of years) of predator access to nesting islands in Stampede and Lahontan Reservoirs

Reservoir	Current conditions	No Action	LWSA	TROA
Stampede	19	22	22	10
Lahontan – Gull Island	25	26	26	26
Lahontan – Evans Island	8	9	9	10

Table 3.63—Frequency (percent of years) of inundation of island nests at Stampede Reservoir

Current conditions	No Action	LWSA	TROA
56	57	58	70

4. Evaluation of Effects

a. No Action

Operations model results show that, under No Action, predator access to islands in Stampede and Lahontan Reservoirs occurs about as frequently as under current conditions (differences of 3 percent and 1 percent, respectively). Under No Action, island nests in Stampede Reservoir are inundated 1 percent more frequently than under current conditions. Such small differences would be unlikely to have long-term effects on populations of island-nesting birds and, therefore, would not be a significant effect.

b. LWSA

Under LWSA, predator access to islands in Stampede and Lahontan Reservoirs and inundation of island nests in Stampede Reservoir occur as frequently as under No Action. Effects would be the same as under No Action.

c. TROA

Under TROA, predator access to islands in Lahontan Reservoir occurs as frequently as under No Action. Effects would be the same as under No Action.

Under TROA, predator access to the island in Stampede Reservoir occurs about 50 percent less frequently than under No Action or current conditions, which would be a significant beneficial effect.

Under TROA, island nests in Stampede Reservoir are inundated 13 percent more frequently than under No Action and 14 percent more frequently than under current conditions. These differences must, however, be weighed against the less frequent predator access to the same island under TROA. Operations model results show that under TROA, predators would have access to the island 10 out of 100 years, while the island would be inundated 70 years, resulting in 20 years conducive to nesting success. Under No Action, predators would have island access 22 years, while the island would be inundated in 57 years, resulting in 21 years conducive to nesting success. Under current conditions, predators could access the island in 19 years, while it would be inundated in 56 years, resulting in 25 years conducive to nesting success. The net effect of TROA, therefore, is a 5-percent reduction compared to No Action and a 20-percent reduction compared to current conditions. While it is possible that either of these reductions could have an adverse effect on local Canada goose nesting success, no significant adverse effect is expected to the regional population. Canada geese are one of the most common waterfowl in the study area. Geese could nest at many other locations in the Truckee River basin when conditions are unfavorable at Stampede Reservoir. Moreover, resident Canada geese present a management problem in many urban areas, including Reno-Sparks.

5. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects on island nesting birds at Lahontan and Stampede Reservoirs would occur under any of the alternatives.

Riparian Habitat and Riparian-Associated Wildlife

I. Affected Environment

Riparian (i.e., along rivers or streams) habitats, because of their moisture gradients, their dynamic response to river processes, and their long complex interfaces between both upland and aquatic habitats, are among the most diverse and biologically productive ecosystems (Naimann et al., 1993). This is particularly true in arid areas such as the Western United States; for example, an investigation on the Inyo National Forest found that riparian areas comprised less than 0.4 percent of the land area but were essential habitat for about 75 percent of local wildlife species (Kondolf et al., 1987).

Riparian vegetation (the plants growing along a stream) plays an important role in riverine ecosystems. Plant roots help stabilize soil, and stems and leaves of emergent vegetation (plants rooted in water) move with the current, decreasing flow velocity and reducing the scouring effects of water. Shade produced by overhanging vegetation helps maintain the cool water temperatures critical for many fish species. Riparian vegetation traps sediment from the watershed, preventing it from settling on food producing areas, spawning sites, fish eggs and fry, and insect larvae. Emergent vegetation provides cover as well as a substrate for organisms and eggs.

Modifying operations of Truckee River reservoirs and the resulting effect on flows could affect the abundance, distribution, and condition of riparian vegetation (Kattelmann and Embury, 1996). During periods of greater flows, portions of the flood plain may be inundated, revitalizing riparian vegetation in those areas. High flows can also remove vegetation and create the mineral surfaces that some riparian plants need for seed germination. Extremely high flows, such as occur during large storm events, may scour the stream channel of established vegetation.

During periods of low flows, particularly if prolonged, riparian vegetation may dry out, shed its leaves, and lose vigor. Some plants may die, reducing habitat for wildlife. Low flows in spring and early summer may not provide sufficient water for seed germination and seedling growth in areas away from the streambed.

Other factors, such as irrigation, runoff from upland areas, and seepage of water from streambanks also affect riparian vegetation. Changes in vegetation composition and structure that result from changes in streamflow often are not immediately obvious and may not become evident for months or even years.

A. Riparian Habitat

The Truckee River originates within mixed conifer-forested mountains and descends to arid shrub-dominated valleys. Over this distance of about 120 miles, the river descends in elevation by over 2,000 feet. The transition zone from montane forest to shrubland begins in the vicinity of the town of Truckee and is not complete until the river reaches the outskirts of Reno, a distance of roughly 35 miles. This broad transition zones marks a shift in flora and fauna between the Mediterranean climate of California and the interior continental climate of the Great Basin (Manley et al., 2000). The obvious shift from forest to shrubland is paralleled by a more subtle change in the structure and composition of riparian vegetation along the Truckee River. The montane riparian forest typified by black cottonwood and pine with an alder-willow understory merges gradually to the Great Basin riparian forest of Fremont's cottonwood and willow shrub, or stands of shrubby willow lacking trees (Caicco, 1998). This great diversity in riparian and upland vegetation along the Truckee River provides a wide variety of habitats for riparian-associated wildlife.

There is no comprehensive list of plant species for the entire Truckee River basin. A recent analysis concluded that the Lake Tahoe basin alone has at least 1,553 vascular and nonvascular plant taxa (Manley et al., 2000). This total excludes many Great Basin plant species that are not found in the Lake Tahoe basin. The total number of riparian plant species along the Truckee River and its tributaries, nevertheless, is likely to be considerably smaller than the total found in the entire Lake Tahoe basin.

Riparian areas along the Truckee River and its tributaries have been affected by a wide variety of human activities and natural disturbances, including grazing by domestic livestock, timber harvest, highway and railroad construction, urban and industrial development, clearing for agricultural uses, invasion by nonnative plant species, fire, landslides, and water impoundment, diversion, and management (Kattelmann and Embury, 1996; Caicco, 1998; Manley et al., 2000). The extent of riparian habitat and land use types found along the Truckee River was mapped from aerial photographs taken in November 1991 (FWS, 1995a). From these maps, the area of various types was calculated (table 3.64). Mapping was restricted to the flood plain and a narrow band of contiguous upland between Lake Tahoe and Marble Bluff Dam. The area of riparian vegetation type along the upper basin tributaries was calculated from National Wetlands Inventory maps (table 3.65).

Three general types in wetlands potentially affected by changes in reservoir operations occur within the study area: palustrine emergent wetlands; palustrine scrub-shrub wetlands; and palustrine forested wetlands. These are discussed in the following sections.

1. Palustrine Emergent Wetlands

Palustrine emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes (i.e., plants adapted to live in very wet habitats, often called emergent vegetation; Cowardin et al., 1979). Such wetlands are dominated by grasses, bulrushes, sedges, and rushes. Two general types of palustrine emergent wetlands occur in the Truckee River

Table 3.64—Riparian and wetland habitats (in acres) along the mainstem of the Truckee River[1]

Riparian and wetland habitats	Lake Tahoe to Boca Reservoir	Boca Reservoir to State line	State line to Vista	Vista to Derby Diversion Dam	Derby Diversion Dam to Wadsworth	Wadsworth to Dead Ox Wash	Dead Ox Wash to Numana Dam	Numana Dam to Marble Bluff Dam	Marble Bluff Dam to Pyramid Lake[2]
Riverine	160	117	219	192	94	70	47	66	38
Pond-like areas[3]	0	0.5	0.5	0	0.2	6	0.2	0.7	0
Ponds	0	0	0.02	0.5	5	0	0	0.8	0
Montane black cottonwood riparian forest	8	81	119	0	0	0	0	0	0
Modoc-Great Basin cottonwood-willow riparian forest	0	0	75	79	105	152	0	79	1
Montane riparian scrub	114	110	0	0	0	0	0	0	0
Modoc-Great Basin riparian scrub	0	0	224	76	106	172	8	184	11
Montane freshwater marsh	5	0	0	0	0	0	0	0	0
Transmontane freshwater marsh	0	0	0.3	5	0	10	5	10	0

[1] Source: FWS, 1995a.
[2] Acreage determined by Reno State Office staff from November 4, 1991, aerial photography and field checked July 1994.
[3] Pond-like areas believed to be hydrologically influenced by the Truckee River.

Table 3.65—Riparian habitats[1] along upstream tributaries to the Truckee River

Tributary	Acres of palustrine wetlands		
	Emergent[2]	Scrub-shrub[3]	Forested[4]
Donner Creek	2	18	0
Prosser Creek	0	4	0
Independence Creek	0.3	22	4
Little Truckee River Independence Creek to Stampede Reservoir	121	11	12
Little Truckee River Stampede Reservoir to Boca Reservoir	78	21	0
Little Truckee River Boca Reservoir to Truckee River	0	0	0

[1] Acres planimetered from FWS National Wetlands Inventory maps (1984).
[2] Palustrine emergent (Cowardin et al., 1979) includes montane freshwater marsh of Holland (1986).
[3] Palustrine scrub-shrub (Cowardin et al., 1979) includes montane riparian scrub of Holland (1986).
[4] Palustrine forested (Cowardin et al., 1979) includes montane black cottonwood riparian forest and mixed pine forest of Holland (1986).

system: montane freshwater marshes/wet meadows, generally found upstream of Verdi; and transmontane freshwater marsh, found downstream from Verdi (Caicco 1998; FWS, 1993; Holland, 1986; FWS, 1995a).

Emergent wetland and other herbaceous vegetation along the edges of rivers and streams commonly expands into the exposed river channel during periods of low flows. Greater flows may scour the emergent vegetation from the stream channel. The total area of emergent vegetation, therefore, can vary considerably in response to flows. A single storm event may produce flows large enough to result in a substantial decrease in the total area of emergent vegetation. The Biological Resources Appendix includes further discussion on the relation between streamside emergent vegetation, vegetated streambeds, and gravel bars.

2. Montane Freshwater Marshes/Wet Meadows

Within the study area, these habitats are generally restricted to a few small islands of vegetation between Tahoe City and the town of Truckee and to bands of vegetation along banks of the Truckee and Little Truckee Rivers. Several ecologically significant marshes occur at the mouths of tributaries at south end of Lake Tahoe (Manley et al., 2000). Smaller marshes or wet meadows also occur at the mouths of tributaries that empty into lakes, reservoirs, and the main stem of the Truckee River. These areas are typically dominated by dense perennial, emergent vegetation. Common plant species include slender-beak sedge, water sedge, and beaked sedge.

The restricted distribution of emergent vegetation and the prevalence of plant species that require a high water table indicate the habitat cannot tolerate extended periods of drought. Such habitats are inundated annually when streamflows are 100 cfs or greater, although annual inundation is not required for all plant species to persist. Flows of 500 cfs or greater may scour emergent plants from the river channel and restrict them to a narrow band along the banks; such streamflows occur about once every 1.5 years (FWS, 1993). The Biological Resources Appendix provides further discussion on frequency of inundation of this habitat.

3. Transmontane Freshwater Marsh

This habitat, which is structurally similar to montane freshwater marsh, also requires frequent inundation or a high water table. It is restricted to small areas and narrow bands of streambank vegetation downstream from Verdi and to a few low-lying areas away from the active steam channel where it may persist due to irrigation runoff or seasonal ponding.

Although no data exist to document the original area and extent of emergent wetlands found along the Truckee River, COE (1992) estimated that 450 acres of palustrine emergent wetlands occurred historically within 164 feet of the river downstream from Sparks. Based on FWS mapping (1995a), 31 acres occurred downstream from Sparks in the early 1990’s, primarily upstream of the Tracy hydroelectric plant and upstream of Derby Diversion Dam.

Other larger examples are found downstream from Dead Ox Wash. Common plant species include cattail, hardstem bulrush, Olney's bulrush, common reed, slender-beak sedge, soft rush, least spikerush, and aquatic species, such as common waterweed and pondweed. The introduced noxious weed, tall whitetop, is also common in these wetlands.

This habitat's restricted distribution and the prevalence of plant species that require a high water table suggest it cannot tolerate long periods of drought. Streamflows of 400 to 600 cfs are usually sufficient to inundate the areas where it is found, and inundation occurs annually (FWS, 1993). Flows of 4,000 cfs or greater likely scour the channel, restricting this community to a narrow band along the banks; such flows occur about once every 3 years (FWS, 1993). See the Biological Resources Appendix for further discussion on this habitat.

4. Palustrine Scrub-Shrub Wetlands

Two types of palustrine scrub-shrub wetlands were identified in the study area: montane riparian scrub and Modoc-Great Basin riparian scrub (Holland, 1986). Palustrine scrub-shrub wetlands are dominated by shrubs or young trees less than 20 feet tall (Cowardin et al., 1979).

a. Montane Riparian Scrub

Montane riparian scrub, a deciduous shrub thicket, is found on the banks and a few gravel bars along the Truckee River upstream of Reno and along upstream tributaries. Mountain alder is the most common plant species. Other associated shrubs include yellow willow, shining willow, coyote willow, dusky willow, and American dogwood. Saplings of black cottonwood are also common. A dense canopy often precludes an extensive herbaceous understory; however, mannagrass, Kentucky bluegrass, and rusty sedge are common (Caicco, 1998; FWS, 1993).

This habitat is inundated every 1 to 5 years with flows of 100 to 6,000 cfs (FWS, 1993). Periodic inundation is needed to prepare mineral surfaces for willow seed germination. Scouring flows that reduce or remove scrub vegetation in the active channel are greater than 8,000 cfs; they occur about once every 10 years and maintain habitat diversity (FWS, 1993; Richter et al., 1996; Poff et al., 1997; Richter and Richter, 2000). The Biological Resources Appendix includes further discussion on inundation of this habitat. Adequate data are not available to determine the magnitude of flows capable of removing vegetation in tributaries to the upper Truckee River.

b. Modoc-Great Basin Riparian Scrub

The Modoc-Great Basin riparian scrub is a generally dense, deciduous thicket found downstream from Verdi along riverbanks, irrigation ditches, and on stable gravel bars (Caicco, 1998; FWS, 1993). Where willows are dominant, coyote willow is the most abundant, although yellow and shining willows are also common. Downstream from Sparks, riparian scrub habitat is often dominated by Fremont cottonwood saplings.

Whether dominated by willow or cottonwood, younger stands often have dense herbaceous understories; older, denser shrub stands usually lack an herbaceous understory. The most common herbaceous species are white sweet-clover, white clover, tall whitetop, and slender-beak sedge. All but the latter are introduced species. A good example of a willow-dominated riparian scrub community occurs in Oxbow Nature Study Park in Reno. Large areas of this habitat are uncommon in the study area, except in the backwaters of some of the higher diversion dams.

Many lower terraces and toe slopes adjacent to the river channel and on gravel bars within the active channel along the lower Truckee River are dominated by cottonwood saplings. Scour during high flows in 1986 and 1997 produced mineral surfaces that enabled abundant cottonwood seed germination in subsequent springs. Flows provided for cui-ui spawning enabled the establishment of the seedlings (Rood et al., 2003). When FWS mapped and collected field data in the early 1990s, most cottonwoods that resulted from the 1986 flood were less than 10 feet high. Such young cottonwoods are initially susceptible to loss during subsequent high flows but become less so after they have become established (Rood et al., 2003). Some unknown proportion of these cottonwood saplings are now 20-30 feet high (Rood et al., 2003). Although these habitats now exceed the 20-foot threshold that distinguishes palustrine scrub-shrub from palustrine forest, their dense, thicket-like structure is distinctly different from more mature cottonwood forests.

Willow-dominated communities appear to be restricted to areas inundated annually, while lower terraces dominated by cottonwood saplings are inundated approximately once every 1 to 5 years; corresponding streamflows are 100 to 6,900 cfs between Reno and Nixon (FWS, 1993). As with montane riparian scrub, occasional scouring flows (greater than 10,000 cfs) are important to remove decadent vegetation and maintain the vigor and diversity of this habitat. Such flows occur about once every 10 years (FWS, 1993). The Biological Resources Appendix has further discussion on inundation of this plant community.

5. Palustrine Forested Wetlands

Palustrine forested wetlands are dominated by woody vegetation at least 20 feet tall (Cowardin et al., 1979). Three riparian forest types occur within the study area: montane black cottonwood, Modoc-Great Basin cottonwood-willow, and aspen. Montane black cottonwood forest and aspen communities are not expected to be affected by changes in reservoir operations but are discussed in the Biological Resources Appendix.

The Modoc-Great Basin cottonwood-willow riparian forest occurs at lower elevations along the Truckee River. Between Verdi and Reno, the flood plain supports a mix of species found in both montane black cottonwood and Modoc-Great Basin cottonwood-willow riparian forests (Caicco, 1998). Downstream from Reno, Fremont cottonwood is the sole dominant tree species in this deciduous forest. Coyote willow is present in the understory in some areas. More commonly, upland shrubs, including big sagebrush and rabbitbrush, are understory dominants. The prevalence of upland shrubs likely reflects a lowered groundwater table. There is little herbaceous understory, but extensive patches of tall whitetop are common. An exceptional example, with a grass understory dominated by slender wheatgrass, occurs in Oxbow Nature Study Park in Reno. More typical examples occur sporadically downstream from Sparks. Mature cottonwood trees, estimated to be up to 140 years old (FWS, 1993), are scattered infrequently on upper terraces now less subject to inundation.

The flood plain once contained more extensive cottonwood forest and scrub than exists today. From Sparks to Derby Diversion Dam, much of the flood plain had been cleared of riparian vegetation for agriculture, livestock grazing, industrial and urban or residential uses, and river channelization. An estimated 7,700 acres of riparian vegetation existed historically in the flood plain between Sparks and Pyramid Lake (COE, 1992); only 974 acres were identified in the early 1990's, an 87-percent loss in riparian vegetation (FWS, 1995a). In most areas, only remnant stands of Fremont cottonwood and willow are found.

In the early 1990's, there were about 80 acres of cottonwood-willow riparian forest between Sparks and Derby Diversion Dam, mostly in small patches (FWS, 1995a). Between Derby Diversion Dam and Marble Bluff Dam, there were an additional 336 acres of cottonwood-willow riparian forest, of which slightly more than half occurred between Wadsworth and Dead Ox Wash. Most stands were small and all were in a degraded condition due primarily to the lowered groundwater table. A more recent study found that 628 acres of riparian forest existed between Sparks and Marble Bluff in 2000 (Otis Bay Consultants, 2003, as cited in TRIT, 2003). This higher estimate is because some proportion of the cottonwood sapling dominated scrub-shrub vegetation has grown sufficiently to be classified as riparian forest.

Based on the 2000 estimate of 628 acres, there has been a 70-percent decrease in riparian forest acreage since 1939 (Otis Bay Consultants, 2003, as cited in TRIT, 2003). Jones and Stokes (1990) estimated that 108 acres of mature cottonwood were lost during the 10-year period from 1976 to 1987, which equates to less than half of the average rate of loss over the 60-year period. This suggests that a greater proportion of the forest was lost prior to 1976, likely as a result of agricultural development. The riparian corridor has also narrowed due to less flows, channel simplification, and stream incision. In 1938, the corridor ranged from about 1,200 to 2,000 feet wide between Wadsworth and Dead Ox Wash (Jones and Stokes, 1990). It currently averages only about 230 feet wide in this reach.

6. Other Wetlands

Several small pond-like areas (in cutoff meanders and low-lying areas on the flood plain) appear to be connected hydrologically to the river (FWS, 1993). These ponds lie entirely on private lands with no public access and, therefore, the potential hydrologic connection cannot be confirmed.

B. Riparian-Associated Wildlife

As with plants, there is no comprehensive list of animals for the entire Truckee River basin. A study confined to the Lake Tahoe basin identified 312 resident or regular visitor vertebrates, a total which includes 217 birds, 59 mammals, 5 amphibians, 8 reptiles, and 23 fish species. Previous studies in the Sagehen Creek Basin, a tributary of the Little Truckee River, have documented that nearly 40 percent of the vertebrates are strongly dependent on riparian habitat (Morrison et al., 1985, as cited in Kattelmann and Embury, 1996). This figure includes all of the 6 amphibians, 5 of 12 reptiles, 17 of 54 mammals, and 46 of 120 birds, but does not include Great Basin taxa that do not occur in the upper reaches of the Truckee River.

1. Birds

Birds show a greater preference for the specific types of riparian habitats along the Truckee River than do most other types of wildlife. Among the riparian types, the greatest number of bird species is found in scrub-shrub (93 species), mature Fremont cottonwood forest (57 species), and pole-sapling Fremont cottonwood (48 species) (Lynn et al., 1998). In contrast to lower elevation riparian areas, higher elevation streams are often bordered by narrow strips of riparian vegetation within extensive coniferous forests, and so have fewer riparian-associated birds and fewer numbers of bird species (Lynn et al., 1998). The large number of bird species downstream from Sparks is due to the extensive riparian scrub-shrub and Fremont cottonwood forest, both habitats that decrease in amount upstream. Higher elevation black cottonwood forests are not as diverse in bird species as the lower Fremont cottonwood riparian forests (Lynn et al., 1998). Although most species use a variety of habitats, some generalizations can be made regarding the use of emergent, scrub-shrub, and forested riparian habitats by individual species based on how often they are observed in these habitats (Lynn et al., 1998). This habitat relationship permits general inferences about the effects of changes in flows on bird species numbers based on predicted changes in the habitats.

Emergent wetlands, although limited along the Truckee River and tributaries, are highly productive ecosystems that provide food, cover, and nesting sites for many species of wildlife. Areas of tall emergent vegetation, such as cattails and bulrushes, provide habitat for birds such as yellow-headed, red-winged, and Brewer’s blackbirds and song sparrows. Some bird species, such as marsh wren, are restricted to tall emergent wetlands. Currently, most of the emergent wetlands are less than 1 acre and occur downstream from Sparks. As a result, emergent wetlands in the Truckee River system provide limited habitat for the above species, as well as limited foraging areas for swallows and other insectivorous birds.

Many populations of emergent wetland bird species have declined historically along the Truckee River. American bittern, sora, northern harrier, marsh wren, savannah sparrow, and common yellowthroat were common along the lower river in the late 1800s (Ridgway, 1877). None of these species was observed in the early 1970s (Klebenow and Oakleaf, 1984). During surveys in 1992 and 1993, marsh wren, savannah sparrow, and common yellowthroat were rarely observed; American bittern, sora, and northern harrier were not observed at all (Lynn et al., 1998). By 2001, however, marsh wren and common yellowthroat were common; savannah sparrow, while once again present, remained rare (Ammon, 2002a). Virginia rail, not observed since the late 1800s, was also present but rare. Neither American bittern nor sora has returned.

The palustrine scrub-shrub habitat is especially important for neotropical migratory birds. Species most frequently observed included American robin, black-billed magpie, Bewick’s wren, brown-headed cowbird, Brewer’s and red-winged blackbirds, song sparrow, warbling vireo, and yellow warbler (Lynn et al., 1998). A historic pattern of decline is also seen in birds associated with scrub-shrub habitats along the lower Truckee River. Black-chinned hummingbird, song sparrow, willow flycatcher, and yellow warbler were all abundant in the late 1800s, while yellow-breasted chat and rufous hummingbird were common and yellow-billed cuckoo rare (Ridgway, 1877). By the early 1970s, none of these species was observed along the lower Truckee River (Klebenow and Oakleaf, 1984). By the early 1990s, all of the species except for yellow-billed cuckoo were once again reported, although all but the song sparrow and yellow warbler were quite rare (Lynn et al., 1998). By 2001, black-chinned hummingbird and yellow-breasted chat were also reported as common (Ammon, 2002a). Yellow-billed cuckoo and rufous hummingbird have not been observed since 1868 and the early 1970s, respectively. Small patches of riparian scrub-shrub vegetation along the Little Truckee River and Independence Creek also support high numbers of bird species, including willow flycatcher (California State Endangered Species), and yellow warbler and yellow-breasted chat (both California Species of Special Concern). They are discussed in “Endangered, Threatened, and Other Special Status Species.”

Fremont cottonwood riparian forest supports the second highest diversity of bird species along the Truckee River. The most common birds in the riparian forest are American robin, black-billed magpie, brown-headed cowbird, European starling, house wren, northern oriole, and red-winged blackbird. There also appears to have been a historic decline in species that prefer cottonwood forests, particularly warbling vireo, Swainson’s hawk, long-eared owl, western tanager, western bluebird, and western wood pewee. Most of these species were reported as abundant or common in 1868 (Ridgway, 1877), but were rare or not observed in the early 1970s (Klebenow and Oakleaf, 1984). By the early 1990’s, warbling vireo, Swainson’s hawk, and western tanager were observed along the lower Truckee River, but remained relatively rare; western bluebird was not observed (Lynn et al., 1998). More recent surveys have found western wood pewee and warbling vireo to be common; western tanager was common during surveys in 1998, but not observed in 2001 (Ammon, 2002a). Long-eared owl has not been reported from the lower Truckee River since 1868 when it was recorded as common.

The total of 107 bird species was reported from the lower Truckee River in 1868 (Ridgway, 1877), compared to 65 in the early 1970s, a decline of 40 percent. Surveys during the early 1990s reported a total of 87 species and, 10 years later, 95 bird species were observed, 89 percent of that reported in 1868 (Ammon, 2002a). While many of the recent additions are either introduced species or species associated with human settlement or agricultural landscapes that were not present in 1868 (Ammon, 2002a), more than 30 species have either increased in abundance or have reappeared after having been extirpated. More than half of these are associated either with emergent or scrub-shrub wetlands, attributed to a substantial increase in early successional riparian vegetation as a result of the implementation of supplemental streamflows designed to restore riparian vegetation beginning in the 1980s (Rood et al., 2003).

The importance of Fremont cottonwoods to birds is noteworthy. Along the lower Truckee River, nearly 40 percent of the 4,399 bird observations were in Fremont cottonwoods (Lynn et al., 1998). Willows were used about 15 percent of the time and were the only other plant species used in excess of 10 percent of the time. Plant use was distributed more evenly and across more species along the upper Truckee River: willow, 21 percent; lodgepole pine, 15 percent; Jeffrey pine, 14 percent; snowberry, 11 percent; and black cottonwood, 11 percent.

Below some threshold width, riparian habitats begin to lose species (Stauffer and Best, 1980, as cited in Dobkin and Wilcox, 1986). In 1938, the riparian corridor ranged from 1,200 to 2,000 feet wide (Jones and Stokes, 1990). In its widest sections, the riparian corridor currently is approximately 500 feet wide, but the average stand width is approximately 125 feet. The area of a riparian forest patch has also been shown to be important for some bird species. For example, in California yellow-billed cuckoo requires riparian areas larger than 12 acres and 66 feet wide to provide nesting habitat (Laymon and Halterman, 1989). The largest stand of riparian forest along the river is 13.5 acres; only about 7 percent of the stands are 5 acres or greater, and 50 percent are less than 1 acre. This may explain, in part, why yellow-billed cuckoo has not recolonized the lower Truckee River.

The small, narrow patches of riparian forest along the Truckee River, with little to no understory, may also make it easier for brown-headed cowbirds to locate and lay their eggs in the nests of other birds (obligate brood parasitism). Brown-headed cowbird brood parasitism has the potential to greatly reduce populations of the host species (Mayfield, 1977). The abundance of cowbirds has increased sharply in the past 100 years, and they are now common throughout the study area (Ridgway, 1877; Lynn et al., 1998). Ten songbird species observed along the lower Truckee River in 1992 and 1993 are frequent or common cowbird hosts (Ehrlich et al., 1988; Lynn et al., 1998). Three of these (willow flycatcher, chipping sparrow, rufous-sided towhee) appear to have declined in abundance or disappeared along the river since 1868.

Certain species require large-diameter trees for nesting and/or roosting. Along the Truckee River, sapsuckers, downy woodpeckers, and northern flickers require large cottonwoods in which they excavate their own nest cavity (primary cavity nesters). These species are important because their nest sites are subsequently used by secondary cavity nesters (occupy cavities excavated by another species). Along the lower Truckee River, native secondary cavity nesters include American kestrel, common merganser, house wren, tree swallow, violet-green swallow, and wood duck. Two introduced secondary cavity nesting species (house sparrow and European starling), which compete with native cavity nesters for nest sites, are common along the lower river. Although many of the native cavity nesters remain common today, their numbers are likely fewer than they were historically. More importantly, the continuing loss of older cottonwood trees and the absence of cottonwoods in middle size classes (Caicco, unpublished data) means that species that require large-diameter trees face a habitat bottleneck within the foreseeable future.

2. Amphibians and Reptiles

Riparian areas provide habitat for amphibians and reptiles, but little is known about their habitat needs (Jennings, 1996; Reynolds et al., 1993). Open water, cool temperatures, and moist soils and microclimates make riparian areas especially important for amphibians (Brode and Bury, 1984; Jennings, 1996). Riparian areas provide breeding sites, areas of escape, and/or foraging sites for reptiles and amphibians. Thirty amphibian and reptilian species are known or are likely to occur in the various riparian habitats along the Truckee River; eight of the amphibians and six of the reptiles also occur in the Lake Tahoe basin (Schlesinger and Romsos, 2000). Ten are obligate riparian species (those found exclusively along watercourses); the others are facultative species (those that use riparian areas but are not totally dependent on them). Yosemite toad and mountain yellow-legged frog are Federal Candidate species (69 FR 24897, May 4, 2004). Northwestern pond turtle and northern leopard frog are Forest Service Sensitive Species. They are discussed further under “Endangered, Threatened, and Other Special Status Species.”

Along the upper Truckee River, common species found in the river and palustrine emergent wetlands include western aquatic garter snake and Pacific treefrog (Panik, 1992). Downstream from Verdi, bullfrog is the most common species, but Pacific treefrogs are also present. Western toads appear to be limited to a few areas; however, the large numbers of tadpoles and juvenile toads present at these sites during the spring suggest a large population of adult toads. Northwestern pond turtles inhabit the Truckee River downstream from Reno in off-channel wetlands, such as permanent oxbows that have been disconnected from the river (Ammon, 2002b).

The reach between Derby Diversion Dam and Pyramid Lake contains the highest observed species diversity of amphibians in the Truckee River system because of sufficient breeding and adult habitat, including ponds for egg and larvae development and a diversity of aquatic and emergent vegetation for cover (Panik, 1992; Panik and Barrett 1994; Ammon 2002b). Bullfrogs, Pacific treefrogs, and western toads are found in this reach. Northern leopard frogs, described by Linsdale (1940) as “the commonest and most widespread kind of frog in the state,” were recorded at only one field site in 1992 in a shallow spring-fed pond and along the river near Dead Ox Wash (Panik, 1992). Three locations with northern leopard frogs were identified on the Pyramid Lake Indian Reservation in 2001 (Ammon, 2002b).

In wet years, high flows may inundate areas away from the main river channel and provide temporary breeding ponds for amphibians if the water persists during egg and larvae development. In average years, the upper and middle portions of the Truckee River have few areas suitable for amphibian breeding or egg and larvae development. However, during the drought of 1992, breeding sites became more prevalent in the upper reaches of the river in major side channels with aquatic and emergent vegetation (Panik, 1992). In dry years, although breeding ponds may be prevalent, they may become desiccated before larvae complete development in late spring or summer. The relative amount of palustrine emergent wetlands and pond-like areas is indicative of potential amphibian breeding habitat along the Truckee River.

Seventeen additional species are thought to occur in the riparian scrub community. Western terrestrial garter snake, western fence lizard, and western aquatic garter snake are the most common. The abundant invertebrate population associated with the riparian scrub plant community provides an important food source for these animals.

3. Mammals

Wetland mammals known or expected to occur along the river and tributaries include muskrat, mink, water shrew, beaver, and river otter. Other mammals, including shrews, insectivorous bats, raccoons, and skunks, may forage on the abundant invertebrates associated with emergent wetlands.

Of the six mammal species that require freshwater streams and/or riparian vegetation, Sierra Nevada mountain beaver and river otter are primarily associated with palustrine scrub-shrub wetlands. Sierra Nevada mountain beaver occurs only in higher elevation riparian thickets of willow, alder, and red and white fir. Historically, river otters occurred throughout the Truckee River system; however, they are currently believed to be present only along the Truckee River near Wadsworth. Deer also use scrub-shrub wetlands along the Truckee River for cover, forage, and fawning. The Loyalton-Truckee mule deer herd winters along the Sierran front north and south of Reno and summers in higher elevation areas throughout the study area. A number of small, scattered resident mule deer herds also occur from Reno to Pyramid Lake.

The cottonwood forest along the lower and middle Truckee River provides habitat for mammals that otherwise would not be expected to occur at this elevation, including the mountain cottontail, western harvest mouse, long-tailed vole, western jumping mouse, bushy-tailed woodrat, porcupine, raccoon, long-tailed weasel, and skunk.

Cavities in cottonwood snags (dead trees) serve as den or resting sites for mammals, such as bats, spotted skunks, raccoons, martens, and weasels. Rodents, rabbits, foxes, raccoons, weasels, skunks, and otters use downed logs as hiding, feeding, and/or nesting areas. In the lower elevations of the study area, riparian forests along the Truckee River are the only sites that provide snag and log habitats. The riparian zone also provides an avenue for wildlife moving from one habitat or geographic area to another and for seasonal movements between high- and low-elevation areas.

II. Environmental Consequences

A. Introduction

Throughout the Sierra Nevada, alterations in flows from impoundments and diversions have affected riparian vegetation. Less flows can lead to low growth rates, a loss of canopy vigor, and high mortality of riparian plants and result in narrowing of riparian corridors, and changes in the species composition and/or structure of riparian vegetation (Harris, 1986; Harris et al., 1987; Stromberg and Patten, 1991). A reduction in flood flows can lead to less frequent scour of the active channel, channel simplification, reduced rates of channel migration, and channel incision and reduced floodplain inundation; such changes lead to the encroachment of riparian vegetation into the active channel and reduced habitat diversity, respectively (Ligon et al., 1995; Kondolf et al., 1996). Three principles have emerged from research on the ecology of regulated rivers: (1) habitat diversity is substantially reduced; (2) native biodiversity decreases and non-native species proliferate; and (3) changes are generally more severe closer to dams and diversions (Stanford et al., 1996).

The rate at which riparian vegetation responds to flow reductions is highly variable. Riparian forest area declines ranging from 23 to 48 percent have been documented over a 20-year interval downstream from dams in southern Alberta (Rood and Heinze-Milne, 1989). In contrast, a study of paired reaches above and below diversions on 11 Sierra Nevadan streams diverted for 50 or more years found no difference on four streams, decreased shrub cover on two streams, decreased herbaceous cover on two streams, decreased shrub and herbaceous cover on one stream, increased herbaceous cover on one stream, and decreased tree cover on one stream; the authors attributed these results to differing environmental characteristics among stream reaches and concluded that streams in the Sierra Nevada respond individualistically to diversions (Harris et al., 1987).

Various methods have been developed to predict the effects of changes in flows on riparian vegetation (Stromberg and Patten, 1990, 1991; Stromberg, 1993; Auble et al., 1994; Stromberg et al., 1996). More recent approaches in predicting streamflow have focused on the entire riverine and riparian ecosystem (Poff et al., 1997; Richter et al., 1997). Such studies generally begin with an analysis of unimpaired regional streamflow patterns to provide a conceptual framework for evaluating the relative importance of various factors (Poff and Ward, 1987). This framework is used to assess divergence from the natural range of hydrologic variability attributable to human influences (Richter et al., 1996, 1997, 2000; Poiani et al., 2000). This allows the development of flow management strategies that, in conjunction with ecosystem monitoring, provide a scientific basis for adaptive management.

The relative amount of riparian vegetation was selected as the indicator for this resource.

B. Summary of Effects

Analysis of operations model results shows that no significant adverse effects on riparian habitat or riparian-associated wildlife species along the Truckee River or any of the affected tributaries would occur under TROA. Significant beneficial effects to both riparian habitat and riparian-associated wildlife along all reaches of the Truckee River in dry and extremely dry hydrologic conditions and along the lowermost reaches of the Truckee River in median hydrologic conditions would occur under TROA (table 3.66). Significant beneficial effects to both riparian habitat and riparian-associated wildlife also would occur along all affected tributary reaches in wet, median, dry, and extremely dry hydrologic conditions under TROA (table 3.67).

C. Relative Amounts of Riparian Habitat

1. Method of Analysis

A comparative analysis of flow characteristics from nine streams in the same climatic region as the Truckee River, all located in areas with similar geomorphologic and topographic characteristics, has shown that the magnitude, frequency, timing, and duration of flood flows in the Truckee River do not differ substantially from natural conditions (TRIT, 2003). None of the alternatives would modify the magnitude, frequency, timing, or duration of flood flows, so such flows are not addressed.

The operations model computes average monthly flows under current conditions, No Action, LWSA, and TROA by river reach (map 3.1). Streamside vegetation also is likely to be influenced by prolonged extremes of high or low flows or by patterns of flow frequency, timing, and duration that are obscured in average monthly flows. Because average monthly flows are only one factor influencing riparian vegetation, best professional judgment was used in evaluating the effects of each alternative on riparian resources.

In lieu of more detailed data, this analysis compares average monthly flows to recommended ecosystem maintenance flows downstream from McCarran Boulevard or to recommended minimum flows (in other reaches and tributaries) from April through October. This period corresponds to the period when riparian plants emerge from winter dormancy, grow, reproduce, and re-enter dormancy, induced either by drought or colder temperatures. The ecosystem maintenance flows for the lower Truckee River incorporate flows critical to the survival of cottonwood trees in dry years (TRIT, 2003; table 3.39). Recommended flows for other reaches in Nevada and California represent minimum fish flows; it is assumed, in the absence of other data on riparian needs, that these flows also represent a critical threshold for riparian vegetation. The analysis focuses first on the potential adverse effects in the months when recommended flows are not met. It also evaluates the potential benefits to riparian resources when recommended minimum flows are exceeded.

Table 3.66—Summary of effects: riparian habitats along the mainstem of the Truckee River (- = significant adverse effect; + = significant beneficial effect). Summary is based on data in Biological Resources Appendix RIPARIAN tables 1-8; 14-21; and 27-34

<table>
<tr><th rowspan="2">Truckee River reach</th><th colspan="3">Compared to current conditions</th><th colspan="2">Compared to No Action</th></tr>
<tr><th>No Action</th><th>LWSA</th><th>TROA</th><th>LWSA</th><th>TROA</th></tr>
<tr><th colspan="6">Wet hydrologic conditions</th></tr>
<tr><td>Lake Tahoe to Donner Creek</td><td colspan="3">No effect</td><td colspan="2" rowspan="8">No effect</td></tr>
<tr><td>Donner Creek to Little Truckee River</td><td>+</td><td colspan="2" rowspan="2">No effect</td></tr>
<tr><td>Little Truckee River through Trophy</td><td>+</td></tr>
<tr><td>Mayberry</td><td>+</td><td>+</td><td>No effect</td></tr>
<tr><td>Oxbow</td><td colspan="3" rowspan="3">No effect</td></tr>
<tr><td>Spice</td></tr>
<tr><td>Lockwood</td></tr>
<tr><td>Downstream from Derby Diversion Dam</td><td>+</td><td colspan="2">No effect</td></tr>
<tr><th colspan="6">Median hydrologic conditions</th></tr>
<tr><td>Lake Tahoe to Donner Creek</td><td colspan="2">No effect</td><td>+</td><td>No effect</td><td>+</td></tr>
<tr><td>Donner Creek to Little Truckee River</td><td colspan="3">No effect</td><td colspan="2" rowspan="4">No effect</td></tr>
<tr><td>Little Truckee River through Trophy</td><td>+</td><td colspan="2">No effect</td></tr>
<tr><td>Mayberry</td><td>+</td><td>+</td><td>No effect</td></tr>
<tr><td>Oxbow</td><td colspan="3" rowspan="3">No effect</td></tr>
<tr><td>Spice</td><td>+</td><td>+</td></tr>
<tr><td>Lockwood</td><td rowspan="2">No effect</td><td>+</td></tr>
<tr><td>Downstream from Derby Diversion Dam</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><th colspan="6">Dry hydrologic conditions</th></tr>
<tr><td>Lake Tahoe to Donner Creek</td><td>-</td><td>+</td><td>No effect</td><td rowspan="8">No effect</td><td>+</td></tr>
<tr><td>Donner Creek to Little Truckee River</td><td></td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Little Truckee River through Trophy</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Mayberry</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Oxbow</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Spice</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Lockwood</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Downstream from Derby Diversion Dam</td><td colspan="2">No effect</td><td>+</td><td>+</td></tr>
<tr><th colspan="6">Extremely dry hydrologic conditions</th></tr>
<tr><td>Lake Tahoe to Donner Creek</td><td colspan="3">No effect</td><td>+</td><td>+</td></tr>
<tr><td>Donner Creek to Little Truckee River</td><td colspan="2">No effect</td><td>+</td><td rowspan="4">No effect</td><td>+</td></tr>
<tr><td>Little Truckee River through Trophy</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Mayberry</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Oxbow</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Spice</td><td>+</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Lockwood</td><td>+</td><td>+</td><td>+</td><td rowspan="2">No effect</td><td>+</td></tr>
<tr><td>Downstream from Derby Diversion Dam</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
</table>

Table 3.67—Summary of effects: riparian habitats along affected tributaries to the Truckee River (- = significant adverse effect; + = significant beneficial effect). Summary is based on data in Biological Resources Appendix RIPARIAN tables 9-13; 22-26; and 35-39

<table>
<tr><th rowspan="2">Tributary reach</th><th colspan="3">Compared to current conditions</th><th colspan="2">Compared to No Action</th></tr>
<tr><th>No Action</th><th>LWSA</th><th>TROA</th><th>LWSA</th><th>TROA</th></tr>
<tr><th colspan="6">Wet hydrologic conditions</th></tr>
<tr><td>Donner Creek</td><td colspan="2">No effect</td><td>+</td><td rowspan="5">No effect</td><td>+</td></tr>
<tr><td>Prosser Creek</td><td colspan="3" rowspan="3">No effect</td><td>+</td></tr>
<tr><td>Independence Creek</td><td>+</td></tr>
<tr><td>Little Truckee River upstream of Stampede Reservoir</td><td>+</td></tr>
<tr><td>Little Truckee River downstream from Stampede Reservoir</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><th colspan="6">Median hydrologic conditions</th></tr>
<tr><td>Donner Creek</td><td>No effect</td><td rowspan="2">No effect</td><td>+</td><td rowspan="5">No effect</td><td>+</td></tr>
<tr><td>Prosser Creek</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Independence Creek</td><td>-</td><td>-</td><td>+</td><td>+</td></tr>
<tr><td>Little Truckee River upstream of Stampede Reservoir</td><td colspan="3">No effect</td><td>+</td></tr>
<tr><td>Little Truckee River downstream from Stampede Reservoir</td><td colspan="2">No effect</td><td>+</td><td>+</td></tr>
<tr><th colspan="6">Dry hydrologic conditions</th></tr>
<tr><td>Donner Creek</td><td>-</td><td>-</td><td>+</td><td rowspan="5">No effect</td><td>+</td></tr>
<tr><td>Prosser Creek</td><td>-</td><td>-</td><td>+</td><td>+</td></tr>
<tr><td>Independence Creek</td><td>-</td><td>-</td><td>+</td><td>+</td></tr>
<tr><td>Little Truckee River upstream of Stampede Reservoir</td><td>No effect</td><td>-</td><td>+</td><td>+</td></tr>
<tr><td>Little Truckee River downstream from Stampede Reservoir</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><th colspan="6">Extremely dry hydrologic conditions</th></tr>
<tr><td>Donner Creek</td><td colspan="2">No effect</td><td>+</td><td rowspan="5">No effect</td><td>+</td></tr>
<tr><td>Prosser Creek</td><td>-</td><td>-</td><td>+</td><td>+</td></tr>
<tr><td>Independence Creek</td><td>-</td><td>-</td><td>+</td><td>+</td></tr>
<tr><td>Little Truckee River upstream of Stampede Reservoir</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>Little Truckee River downstream from Stampede Reservoir</td><td>+</td><td>+</td><td>+</td><td>+</td></tr>
</table>

The analysis evaluates the effects of differences in flows on the maintenance of riparian habitats and, by extension, to riparian-associated wildlife. Habitat and, in particular, habitat structure, as a surrogate measure in predictive modeling of wildlife status, while not without limitations, is widely accepted especially where detailed information about the distribution and status of animals is limited (Schroeder and Allen, 1992; Morrison et al., 1998; Roloff et al., 2001).

2. Threshold of Significance

Operation models results show that there are relatively few months in which average monthly flows in any given reach differ by more than 15 percent among current conditions and the alternatives. At a 10-percent difference in flows, however, distinct patterns emerge. Therefore, an effect was identified as significantly adverse whenever the average monthly flows were 10 percent or more less than the flows to which they were compared in any month when either recommended minimum flows (reaches 1-12; map 3.1) or recommended ecosystem flows (reaches 13 and 14; map 3.1) were not met from April through October. An effect was identified as significantly beneficial whenever the average monthly flows were 10 percent or more greater than the flows to which they were compared in any month, regardless of whether the recommended minimum or ecosystem flows were met or not. Significance (adverse or beneficial) was based on best professional judgment and considered the timing and duration of the greater or less flows (i.e., when they occurred during the growing season and for how many months it extended) as well as the flows in the month or months that preceded and followed.

3. Model Results

a. Truckee River Reaches

Operations model results show that recommended minimum flows between Lake Tahoe and Donner Creek generally are not met under current conditions or any alternative from August through October in dry hydrologic conditions, and from July though October in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 1). Recommended minimum flows are always met in wet and median hydrologic conditions.

From Donner Creek through the Trophy reach, recommended minimum flows generally are not met in September and October in extremely dry hydrologic conditions (Biological Resources Appendix, tables RIPARIAN 2 and 3). From the Mayberry reach through the Spice reach, recommended minimum flows generally are not met from August through October in extremely dry hydrologic conditions (Biological Resources Appendix, tables RIPARIAN 4-6).

Downstream from Sparks, recommended ecosystem flows for the Truckee River are not met under current conditions or any alternative in June and July in wet hydrologic conditions and in all months in dry or extremely dry hydrologic conditions (Biological Resources Appendix, tables RIPARIAN 7 and 8).

b. Upper Tributary Reaches

In Donner Creek, recommended minimum flows are not met in August in wet hydrologic conditions and in July and August in median hydrologic conditions under current conditions or the alternatives. In dry and extremely dry hydrologic conditions, recommended minimum flows are not met from May through October (Biological Resources Appendix, table RIPARIAN 9).

In Prosser Creek, recommended minimum flows are not met under current conditions or the alternatives in August and September in median hydrologic conditions. In dry and extremely dry hydrologic conditions, recommended minimum flows are not met under current conditions or the alternatives in April and from July through October; recommended minimum flows also are not met under No Action or LWSA in June in extremely dry conditions (Biological Resources Appendix, table RIPARIAN 10).

Independence Lake releases do not meet recommended minimum flows for Independence Creek under No Action and LWSA in August in median hydrologic conditions. In dry hydrologic conditions, recommended minimum flows are not met under No Action, LWSA, or TROA in April; and under current conditions, No Action, and LWSA from June through September. In extremely dry hydrologic conditions, recommended minimum flows are not met under current conditions, No Action, and LWSA from April through September. Recommended minimum flows for Independence Creek are not met under TROA in July in dry hydrologic conditions or in July and August in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 11).

In the Little Truckee River upstream of Stampede Reservoir, operations model results show recommended minimum flows are not met under No Action and LWSA in August or under current conditions or any alternative in October in median hydrologic conditions. In addition, recommended minimum flows are not met from July through October in dry hydrologic conditions or from June through October in extremely dry hydrologic conditions under current conditions or any alternative (Biological Resources Appendix, table RIPARIAN 12).

Downstream from Stampede Reservoir, recommended minimum flows in the Little Truckee River are not met under current conditions or any alternative in September and October in median hydrologic conditions. In dry hydrologic conditions, recommended minimum flows are not met under current conditions or any alternative in June or from August through October. Recommended minimum flows also are not met in extremely dry hydrologic conditions under current conditions or any alternative from May through October (Biological Resources Appendix, table RIPARIAN 13).

4. Evaluation of Effects

a. No Action

(1) Truckee River Reaches

Operations model results show that, under No Action, in the months when recommended minimum flows between Lake Tahoe and Donner Creek are not met, flows are about 20 percent less than under current conditions in September in dry and extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 14). When plants are already stressed, this situation is likely to cause many riparian plants to shed their leaves and enter dormancy early. While most riparian plants are likely to survive such an event and re-emerge the next spring, they are likely to be less vigorous because they will not have had sufficient time to store energy prior to entering dormancy. Consecutive years of dry or extremely dry hydrologic conditions are likely to cause the death of individual plants, leading to change in riparian community structure, process, and function. This would typically be a shift in dominance from riparian shrubs either to emergent herbaceous plants or, during extended droughts, to herbaceous plants adapted to upland conditions. The latter condition, a narrowing of the riparian zone, would be a significant adverse effect. While flows under No Action are 10 percent or more greater than under current conditions in October in dry and extremely dry hydrologic conditions, riparian plants are unlikely to recover from the adverse effects of the previous month's low flows.

From Donner Creek through the Spice reach, flows under No Action are 10 percent or more less than under current conditions in the months when recommended minimum flows are not met only in September in extremely dry hydrologic conditions (Biological Resources Appendix, tables RIPARIAN 15-19). Although this is a potential adverse effect, it likely would be offset by substantially greater flows in preceding months, which should increase the available water in the soil matrix. Significant beneficial flow increases under No Action when compared to current conditions also occur in most reaches between July and September in dry hydrologic conditions, and in several reaches in October in wet or median hydrologic conditions.

Flows in the Lockwood reach under No Action are 10 percent or more less than under current conditions in April and May in dry hydrologic conditions and in April in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 20). Although greater flows are required for cottonwood recruitment in April and May, flows in this reach are always inadequate for seed germination in dry and extremely dry hydrologic conditions. Therefore, this potential adverse effect likely would be offset by substantially greater flows later in the summer. Flows downstream from Derby Diversion Dam under No Action are more than 40 percent less than under current conditions in September in extremely dry hydrologic conditions, but any adverse effects of these low flows likely would be offset by substantially greater flows in all preceding months (Biological Resources Appendix, table RIPARIAN 21).

(2) Tributary Reaches

In Donner Creek, flows under No Action and current conditions differ by 10 percent or more only in September and October in dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 22). Flows that are 25 percent less in September likely would cause some riparian shrubs to shed their leaves and enter dormancy, which would be a significant adverse effect. Greater flows in October would be unlikely to compensate for this adverse effect. Several successive years in dry hydrologic conditions could lead to a loss of vigor in individual shrubs and a decrease in the total extent of riparian shrub vegetation, leading to change in riparian community structure, process, and function.

In Prosser Creek, flows under No Action are 35-50 percent less under than under current conditions in the months when recommended minimum flows are not met in July in dry and extremely dry conditions (Biological Resources Appendix, table RIPARIAN 23). Less flows in the middle of the growing season would be likely to inhibit the growth and reproduction of riparian plants, especially those growing at the edge of the riparian zone. Consecutive years of dry or extremely dry hydrologic conditions could lead to a substantial narrowing of the riparian corridor, which would be a significant adverse effect. Flows under No Action are greater than under current conditions in October in median hydrologic conditions and would provide a significant beneficial effect by extending the growing season of riparian plants. Greater flows in October in dry hydrologic conditions and in May in extremely dry hydrologic conditions would be unlikely to compensate for less flow in July, which occurs under such conditions.

In Independence Creek, in the months when recommended minimum flows are not met, flows under No Action are 10 percent or more less than under current conditions in August in median hydrologic conditions, in June in dry hydrologic conditions, and from April through June in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 24). Less flow in the early and middle parts of the growing season would be unlikely to be offset by greater flows that occur in October in these hydrologic conditions and, therefore, are all significant adverse effects.

In the Little Truckee River upstream of Stampede Reservoir, in the months when recommended minimum flows are not met, flows under No Action are 10 percent or more less than under current conditions only in July in dry and extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 25). Although this is potentially significant, flows are only 1 cfs less, and no significant adverse effect is expected. Under No Action, flows that are 10 percent or more greater than under current conditions occur in September and October in extremely dry hydrologic conditions. These greater flows would likely provide a significant beneficial effect by extending the growing season or supplying additional water during the growing season for riparian shrubs and trees in this reach.

Operations model results show that flows under No Action in the Little Truckee River downstream from Stampede Reservoir would not result in a significant adverse effect when compared to current conditions in any hydrologic condition (Biological Resources

Appendix, table RIPARIAN 26). Flows under No Action are 10 percent or more greater than under current conditions in October in wet hydrologic conditions and in July in dry and extremely dry hydrologic conditions. By extending the growing season or supplying additional water during the growing season, especially in dry and extremely dry hydrologic conditions, these greater flows would provide a significant beneficial effect.

b. LWSA

(1) Truckee River Reaches

In the Truckee River between Lake Tahoe and Donner Creek, flows are the same under LWSA and No Action, except in October in extremely dry hydrologic conditions, when they are 10 percent or more greater (Biological Resources Appendix, table RIPARIAN 27). These greater flows would provide a significant beneficial effect by extending the growing season for riparian shrub and forest vegetation. In the months when recommended minimum flows are not met, flows under LWSA are 10 percent or more less than under current conditions in September in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 15). This potential adverse effect likely would be offset by greater flows in August and October.

In the Spice reach, flows differ 10 percent or more between LWSA and No Action only in October in dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 32). This would be a significant beneficial effect under LWSA. From Donner Creek through the Spice reach, flows under LWSA are 10 percent or more less than under current conditions in the months when recommended minimum flows are not met only in September in dry hydrologic conditions (Biological Resources Appendix, tables RIPARIAN 15-19). This potentially adverse effect would be offset by substantially greater flows in preceding months and in October in such conditions. In all but reach 7, greater flows in preceding months would result in a significant beneficial effect when compared to current conditions. A significant beneficial effect would occur under LWSA when compared to current conditions in most reaches from July through September in dry hydrologic conditions, and in several reaches in October in wet or median hydrologic conditions (Biological Resources Appendix, tables RIPARIAN 15-19).

Flows in the Lockwood reach do not differ by 10 percent or more between LWSA and No Action. Flows under LWSA are 10 percent or more less than under current conditions in April and May in dry hydrologic conditions and in April in extremely dry hydrologic conditions. The effect would not be adverse because flows adequate for cottonwood regeneration do not occur in dry and extremely dry hydrologic conditions and because of substantially greater flows in subsequent months (Biological Resources Appendix, table RIPARIAN 20). Under LWSA, flows in this reach also are 10 percent or more greater than under current conditions in August and September in median hydrologic conditions. These greater flows would result in a significant beneficial effect.

Flows downstream from Derby Diversion Dam do not differ by 10 percent or more between LWSA and No Action (Biological Resources Appendix, table RIPARIAN 34). Flows under LWSA are nearly 40 percent less than under current conditions in September in extremely dry hydrologic conditions, but any adverse effects would be offset by substantially greater flows in all preceding months (Biological Resources Appendix, table RIPARIAN 21).

(2) Tributary Reaches

In Donner Creek, flows under LWSA are 10 percent or more greater than under No Action only in October in dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 35). The small difference would be unlikely to provide much benefit this late in the growing season. Flows differ by 10 percent or more from those under current conditions only in September in dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 22). Flows that are 25 percent less would be a significant adverse effect; some riparian shrubs would likely shed their leaves and enter dormancy early under such conditions. Greater flows in October would be unlikely to compensate for this adverse effect because these plants are unlikely to re-emerge from dormancy this late in the growing season. Several successive years of dry hydrologic conditions could lead to a loss of vigor and death of individual shrubs and a decrease in the total extent of riparian shrub vegetation.

Flows in Prosser Creek do not differ by 10 percent or more between LWSA and No Action (Biological Resources Appendix, table RIPARIAN 36). Flows under LWSA are 10 percent or more less than under current conditions in the months when recommended minimum flows are not met in July in dry and extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 23). This would be a significant adverse effect. Under LWSA, flows in October in median and dry hydrologic conditions and in May in extremely dry hydrologic conditions are greater than under current conditions. The greater October flows would be unlikely to provide much benefit to riparian vegetation because they would occur too late in the growing season. Any benefits of greater May flows in extremely dry hydrologic conditions likely would be offset by less flow in July.

Flows in Independence Creek do not differ by 10 percent or more between LWSA and No Action (Biological Resources Appendix, table RIPARIAN 37). In the months when recommended minimum flows are not met, flows under LWSA are 10 percent or more less than under current conditions in August in median hydrologic conditions, in April and June in dry hydrologic conditions, and from April through June in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 24). Successive years of dry or extremely dry hydrologic conditions are likely to lead to the death of individual riparian shrubs, perennial herbs, and grasses and also to a significant narrowing of the riparian corridor. This would be a significant adverse effect.

Flows in the Little Truckee River upstream of Stampede Reservoir do no differ by 10 percent or more between LWSA and No Action (Biological Resources Appendix, table RIPARIAN 38). In the months when recommended minimum flows are not met, flows under LWSA are 10 percent or more less than under current conditions only in July in dry and extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 25). Although this is a potential adverse effect, flows are only 1 cfs less and no significant adverse effect is expected. Flows under LWSA are 10 percent or more greater than under current conditions only in September and October in extremely dry hydrologic conditions. These flows would likely provide a significant beneficial effect by extending the growing season for riparian vegetation in this reach.

Flows in the Little Truckee River downstream from Stampede Reservoir do not differ by 10 percent or more between LWSA and No Action (Biological Resources Appendix, table RIPARIAN 38). Flows under LWSA are never 10 percent or more less than under current conditions in any hydrologic condition (Biological Resources Appendix, table RIPARIAN 26). Flows under LWSA are 10 percent or more greater than under current conditions in October in wet hydrologic conditions and in July in dry and extremely dry hydrologic conditions. These greater flows would be a significant beneficial effect.

c. TROA

(1) Truckee River Reaches

Operations model results show that in the Truckee River between Lake Tahoe and Donner Creek, flows under TROA are 10 percent or more less than under No Action only in September in dry hydrologic conditions, a potentially adverse effect that would be offset by substantially greater flows from May through June (Biological Resources Appendix, table RIPARIAN 27). Flows under TROA are 10 percent or more greater than under No Action in July in median hydrologic conditions and in October in dry and extremely dry hydrologic conditions. In the months when recommended minimum flows are not met, flows under TROA are 10 percent or more less than under current conditions in September in dry hydrologic conditions and in August and September in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 14). Potentially adverse effects would be likely in dry hydrologic conditions in most other months and in October in extremely dry hydrologic conditions.

Under TROA, in the Truckee River from Donner Creek through the Spice reach, flows in the Truckee River are never 10 percent or more less than under No Action (Biological Resources Appendix, tables RIPARIAN 28-32). Flows under TROA are 10 percent or more greater than under No Action in September and October in dry hydrologic conditions in most reaches. In extremely dry hydrologic conditions, flows under TROA are 10 percent or more greater than under No Action from August though October from the confluence of the Little Truckee River through the Mayberry reach, and from June through October in the Oxbow and Spice reaches. These would be significant beneficial effects that would enhance the vigor of riparian shrub and forest vegetation. Flows under TROA are never 10 percent or more less than under current conditions during months when recommended minimum flows are not met (Biological Resources Appendix, tables RIPARIAN 15-19). Significant beneficial effects would occur in all reaches when TROA is compared to current conditions, especially in dry and extremely dry hydrologic conditions. These greater flows occur only from August through October in the uppermost reach, but they occur from July though October in dry hydrologic conditions and from June through October in extremely dry conditions from the Mayberry reach through the Spice reach. These greater flows would enhance the vigor of riparian vegetation, which would be a significant beneficial effect.

In the Lockwood reach, flows under TROA are never 10 percent or more less than under No Action, but they are 10 percent or more greater from June through October in dry hydrologic conditions and from June through October in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 33). These greater flows would enhance the vigor of riparian shrub and forest vegetation along the lower Truckee River and would be a significant beneficial effect. Flows under TROA are 10 percent or more less than under current conditions in May in dry hydrologic conditions and in April in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 20). The potentially adverse effects of these low spring flows would be offset by substantially greater flows from August through October in dry hydrologic conditions and from June through October in extremely dry hydrologic conditions because TROA would allow the release of water to be withheld in the spring in order to create Credit Water that could then be released later in the year or in a subsequent year to enhance flow during low-flow periods.

Downstream from Derby Diversion Dam, flows under TROA are 10 percent or more greater than under No Action in April and June in median hydrologic conditions (Biological Resources Appendix, table RIPARIAN 34). This would be a significant beneficial effect and reflects the intent of TROA to make more water available for cottonwood regeneration when sufficient water is available. Flows under TROA also are 10 percent or more greater than under No Action in August in dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 34). In extremely dry hydrologic conditions, flows under TROA are 10 percent or more greater than under No Action in April and from July through October. These greater flows would enhance the maintenance of riparian shrub and forest vegetation and would be a significant beneficial effect. Flows under TROA are 10 percent or more greater than under current conditions in July in wet hydrologic conditions; in June, August, and September in median hydrologic conditions; in August in dry hydrologic conditions; and in all months in extremely dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 21). These greater flows would result in significant beneficial effects.

(2) Tributary Reaches

In Donner Creek, flows differ by 10 percent or more between TROA and current conditions only in May in dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 22). This potentially adverse effect would be offset by substantially greater flows from June through October. Flows under TROA also are greater than under current conditions in August in wet hydrologic conditions, in July and August in median hydrologic conditions, and from June through October in extremely dry hydrologic conditions. These greater flows would enhance the vigor of riparian vegetation and would be a significant beneficial effect. Operations model results show the same pattern of significant beneficial flows when TROA is compared to No Action (Biological Resources Appendix, table RIPARIAN 36).

In Prosser Creek, flows under TROA are never 10 percent or more less than under No Action. Flows under TROA are never 10 percent or more less than under current conditions during months when recommended minimum flows are not met (Biological Resources Appendix, table RIPARIAN 23). Flows under TROA are greater than under current conditions in September in wet hydrologic conditions, in August and September of median hydrologic conditions, from April and June though October in dry hydrologic conditions, and in May and July though October in extremely dry hydrologic conditions. These greater flows would enhance the vigor of riparian vegetation.

In Independence Creek, in the months when recommended minimum flows are not met, flows under TROA are 10 percent or more less than under current conditions only in April in dry hydrologic conditions (Biological Resources Appendix, table RIPARIAN 24). This potentially adverse effect would be offset by substantially greater flows from June though September. Flows under TROA also are greater than under current conditions in October in wet hydrologic conditions, in August and October in median hydrologic conditions, and in April and from July though October in extremely dry hydrologic conditions. These greater flows would enhance the vigor of riparian vegetation and would be a significant beneficial effect. Operations model results show the same pattern of beneficial flows when TROA is compared to No Action, although in most months, flows are considerably greater (Biological Resources Appendix, table RIPARIAN 37).

Flows in the Little Truckee River upstream of Stampede Reservoir under TROA are never 10 percent or more less than under current conditions (Biological Resources Appendix, table RIPARIAN 25). Flows under TROA are greater than under current conditions in October in wet hydrologic conditions; in July and August in median hydrologic conditions; from June though September in dry hydrologic conditions; and in April and from July though October in extremely dry hydrologic conditions. These greater flows would enhance the vigor of riparian vegetation and would be a significant beneficial effect. Operations model results show the same general pattern of significant beneficial flows when TROA is compared to No Action (RESOURCES APPENDIX, table RIPARIAN 38).

Downstream from Stampede Reservoir, flows in the Little Truckee River under TROA are greater than under No Action in September in wet hydrologic conditions; from August though October in median hydrologic conditions; and in all months except July in dry hydrologic conditions. These greater flows would enhance the vigor of riparian vegetation and would be a significant beneficial effect. Flows under TROA are

10 percent or more less than under No Action only in July in extremely dry hydrologic conditions. This potentially adverse effect would be offset by greater flows in all other months under such conditions.

Flows under TROA are never 10 percent or more less than under current conditions (Biological Resources Appendix, table RIPARIAN 26). Flows are greater in September and October in wet and median hydrologic conditions, in May, June, and August through October in dry hydrologic conditions, and from May though October in extremely dry hydrologic conditions. These greater flows would enhance the vigor of riparian vegetation and would be a significant beneficial effect.

5. Mitigation and Enhancement

No mitigation would be required because of the benefits and enhanced environmental conditions that would occur under TROA. Riparian habitat for riparian-associated wildlife species would be enhanced under TROA.

Endangered, Threatened, and Other Special Status Species

Modifying operations of Truckee River reservoirs could affect elevations of lakes and reservoirs and the quality, quantity, timing, and duration of flows in the Truckee River and its tributaries. These changes could affect the life histories, habitat, and potential for recovery of endangered, threatened, and other special status species.

Lake and reservoir elevations, as well as flows, influence fish access to streams for spawning, thereby affecting their ability to reproduce, which may, in turn, affect the aquatic prey base for birds that forage on fish. The reproductive success of birds nesting on islands may be reduced if a landbridge forms as a result of low elevations in certain reservoirs. Changes in the elevation of Lake Tahoe could affect the acres of beach habitat available for Tahoe yellow cress, thereby affecting populations of this plant. Acres of riparian habitat used by special status species along streams also may change over time with changes in flows.

Forty-three special status species that could be affected by the alternatives occur or potentially occur in the study area. Federal endangered, threatened, and candidate species that could be affected and their distributions are listed in table 3.68. An “endangered species” is defined as a species in danger of extinction throughout all or a significant portion of its range. A “threatened species” is defined as a species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. If a federally listed species may be affected by the proposed action, consultation with FWS under section 7(c) of ESA will be completed. Also shown in table 3.68 are species listed by the States of California and Nevada as endangered or threatened.

Other Federal and State special status species also could be affected (table 3.69). FWS Birds of Conservation Concern include “species, subspecies, and populations of migratory non-game birds that, without additional conservation actions, are likely to become candidates for listing under ESA. Candidate species are those for which FWS has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species, but for which development of a listing regulation is precluded by other higher priority listing activities. U.S. Forest Service (USFS) “sensitive species” are recognized as needing special management to prevent them from becoming endangered or threatened (Bergen and Barker, 1990).

CDFG’s “Species of Special Concern” designation applies to species that are not already included on Federal or California endangered, rare, or threatened lists, but are declining or are so few in number in California that extirpation is a possibility. Species on this list

Table 3.68—Federal and State endangered, threatened, and candidate species occurring or having the potential to occur in the study area that could be affected by modifying reservoir operations

Species	Status[1]	Habitat	Distribution
Plants			
Tahoe yellow cress, *Rorippa subumbellata*	C; FSS CE; NE	Beaches and margins of drainages that flow across beaches; sandy or cobbly substrates with little soil formation and good drainage	Endemic to Lake Tahoe Basin, with exception of historic record from Truckee, California
Fishes			
Cui-ui, *Chasmistes cujus*	E; NE	Freshwater lake and inflows	Only population is in Pyramid Lake; spawns in lower Truckee River
Lahontan cutthroat trout, *Oncorhyncus clarki henshawi*	T	Coldwater rivers, streams, and lakes	Lahontan Basin in northern Nevada, eastern California, and southern Oregon; Pyramid Lake, Truckee River, and Independence Lake
Birds			
Swainson's hawk, *Buteo swainsoni*,	BCC; CT	Associated western grasslands; nests predominantly in cottonwoods and elms in agricultural valleys	Documented nesting near Truckee River; possible breeding in the Lahontan Valley
Bald eagle, *Haliaeetus leucocephalus*	T; CE; NE	Nests and roosts in trees near lakes, reservoirs, and rivers	Nests in upper Truckee River basin, at Lake Tahoe, and at Lahontan Reservoir; winters throughout study area; fall concentrations at Taylor Creek and Little Truckee River during kokanee spawning
Willow flycatcher, *Empidonax traillii*	FSS; CE	Nests in riparian areas with broad, flat meadows containing dense willows	Historic records along lower Truckee River; recent records along Little Truckee River, upper Truckee River, and vicinity of Independence Lake; Little Truckee River supports the second largest population in California
Mammals			
Spotted bat, *Euderma maculatum*	CSSC; NT	Deserts to high mountains; roosts primarily in crevices in cliffs near water; may forage in riparian areas	Western States, including California and Nevada; documented in seven counties in Nevada; three specimens from Reno, Washoe County

[1] Status: Federal E = endangered; T = threatened; C = Candidate; BCC = FWS Bird of Conservation Concern; FSS = Forest Service sensitive species.
State NE = Nevada endangered; NT = Nevada Threatened; CE = California Endangered; CT = California Threatened; CSSC = California Department of Fish and Game Species of Special Concern

Table 3.69—Federal and State special status species occurring or having the potential to occur in the study area that could be affected by modifying operations of Truckee River reservoirs

Species	Status	Habitat	Distribution
Plants			
Shore sedge, *Carex limosa*	CNPS 2	Lake and pond lake margins, bogs and fens, and along low gradient streams often growing in sedge or sphagnum peat; elevation range 3936 – 8856 feet	Nevada and El Dorado Counties, California, vicinity of Sagehen Creek and Grass Lake
Grants Pass willowherb, *Epilobium oreganum*	FSS; CNPS 1B	Small streams, ditches, and bogs in lower montane coniferous forests; elevation range 1640 – 7350 feet	Nevada, Placer, and El Dorado Counties, California; vicinity of Sagehen Creek and Echo Summit
American manna grass, *Glyceria grandis*	CNPS 2	Wet places, meadows, lake and stream margins; elevation range 50 – 6495 feet	Placer County; vicinity of Squaw Creek and Truckee River
Marsh skullcap, *Scutellaria galericulata*	CNPS 2	Wet sites, meadows, streambanks, coniferous forest; elevation range 0 – 6888 feet	Nevada, El Dorado, and Placer Counties, California; vicinity of Truckee River
Plumas ivesia, *Ivesia sericoluca*	CNPS 1B	Meadows, rocky streams, and vernal pools within sagebrush and upper montane forest; elevation 4600 – 6600 feet	Vicinity of Stampede Reservoir, Prosser Creek Reservoir, Little Truckee River, and Truckee River
Slender-leaved pondweed, *Potamogeton filiformis*	CNPS 2	Shallow, clear water of lakes and drainage channels; elevation range 984 – 7052 feet	Placer County, California; historic record from Lake Tahoe
White-stemmed pondweed, *Potamogeton praelongus*	CNPS 2	Deep water, lakes; elevation range 5900 – 9840 feet	Sierra County, California
Water bulrush, *Scirpus subterminalis*	CNPS 2	Lakes, ponds, and marshes; elevation range 2460 – 7380 feet	Nevada and El Dorado Counties, California; vicinity of Grass and Upper Angora Lakes
Veined water lichen, *Hydrothyria venosa*	FSS	Clear, flowing, mid- to high-elevation streams where water quality appears to be very good	Known from Calaveras to Tulare Counties, California
Three-ranked hump-moss, *Meesia triquetra*	FSS; CNPS 2	Meadows and seeps, damp soil within upper montane coniferous forest; elevation range 4264 – 8200 feet	Nevada and El Dorado Counties, California
Broad-nerved hump-moss, *Meesia uliginosa*	FSS	Meadows and seeps, bogs and fens, upper montane coniferous forest; elevation range 4264 – 8200 feet	Nevada County, California

Table 3.69—Federal and State special status species occurring or having the potential to occur in the study area that could be affected by modifying operations of Truckee River reservoirs – continued

Species	Status	Habitat	Distribution
Invertebrates			
California floater, *Anodonta californiensis*	NNHP S1?	Water less than 6.5 feet deep in lakes and rivers; usually slow moving water; adults in sand, mud, or stream bottom	Historic record in Truckee River, late 1800s
Great Basin rams-horn, *Helisoma newberryi newberryi*	FSS	Large spring complexes	Reported from Lake Tahoe and adjacent downstream slow-flowing segment of the Truckee River
Nevada viceroy, *Limenitus archippus lahontani*	NNHP S1S2	Riparian habitats with willows, its host plant	Apparently restricted to Nevada where known from the Humboldt River and near Fallon and Fernley
Aquatic moth, *Petrophila confusalis*	NNHP S1	Well-oxygenated water of streams and lakes	Known to occur in Pyramid Lake
Fishes			
Mountain sucker, *Catostomus platyrhynchus*	CSSC	Small, clear mountain streams with rubble, sand, or boulder bottoms; occasionally lakes or reservoirs	Sagehen Creek, Little Truckee River, Prosser Creek, Martis Creek, and Truckee River
Amphibians			
Northern leopard frog, *Rana pipiens*	FSS	Brackish and freshwater marshes with dense vegetation; desert lowlands to high mountain meadows	Lower reach of Truckee River; 8.0 to 12.0 miles upstream from Pyramid Lake
Reptiles			
Northwestern pond turtle, *Clemmys marmorata*	FSS	Inhabits permanent and intermittent aquatic habitat. Hatchlings prefer water less than 1 foot deep with emergent vegetation	Suitable habitat has been identified in three areas along the Truckee River (Holland, 1991)
Birds			
Northern harrier, *Circus cyaneus*	CSSC	Uses wetlands, meadows, and agricultural areas	Year-round resident in Nevada; probable breeding near Truckee River; lower Truckee River
American white pelican, *Pelecanus erythrorhynchos*	NNHP S2, CSSC	Islands in freshwater lakes used for breeding; forages in rivers, lakes, and marshes	Anaho Island supports one of largest breeding colonies in US; forages in Pyramid Lake, Humboldt Sink, Honey Lake, Stillwater Marshes, Carson Lake, and Truckee River; winters on California coast and Central Valley

Table 3.69—Federal and State special status species occurring or having the potential to occur in the study area that could be affected by modifying operations of Truckee River reservoirs – continued

Species	Status[1]	Habitat	Distribution
Birds (continued)			
Long-billed curlew, *Numenius americanus*,	FSS BCC/CSSC	Nests in emergent wetlands, meadows, and pastures	Summer resident in Nevada; occasional sightings on lower Truckee River
California gull, *Larus californicus*	CSSC	Nests colonially on islands; forages in a variety of habitats	Nests colonially on Ahaho Island and the island in Lahontan Reservoir; winters on west coast
Osprey, *Pandion haliaetus*	CSSC, NNHP S2	Nests in snags near lakes or rivers with abundant fish	Nests at Lake Tahoe and Stampede Reservoir; formerly nested at Lahontan and S-Line Reservoirs; observed throughout Nevada during spring and fall migrations
Yellow warbler, *Dendroica petechia*	CSSC	Nests in riparian thickets (especially willow) and riparian forest with dense understories	Along Truckee River and tributaries
Yellow-breasted chat, *Icteria virens*	CSSC	Nests in dense riparian thickets in valleys	Historically common along lower Truckee River, but now rare; possible breeding near Truckee River
Mammals			
Pale Townsend's big-eared bat, *Corynorhinus townsendi*	FSS/CSSC	Roosts in caves and mines in a variety of habitats; may forage in riparian areas	Historic records near Pyramid Lake, Stillwater, and Fallon
Fringed myotis, *Myotis thysanodes*	NNHP S2	From low desert to fir-pine forests	Throughout study area
Pallid bat, *Antrozous pallidus*	FSS/CSSC	Primarily open lowland habitats below 6600 feet; roosts in caves, tunnels, and hollow trees; feed almost entirely on the ground	Nevada portion of study area
Western red bat, *Lasiurus blossevillii*	FSS	Found primarily in wooded habitats including cottonwood/willow riparian areas	Rare in Nevada; documented in four Nevada counties including southern Washoe and eastern Churchill Counties

[1] Status: Federal: BCC = FWS Bird of Conservation Concern; FSS = Forest Service sensitive species
State: CSSC = California Department of Fish and Game Species of Special Concern; CNPS = California Native Plant Society (1B = Rare or endangered in California and elsewhere; 2 = Rare and endangered in California, more common elsewhere); NNHP = Nevada Natural Heritage Program (S1 = Critically imperiled in Nevada due to extreme rarity, imminent threats, and/or biological factors; S2 = Imperiled in Nevada due to rarity and/or other demonstrable factors).

have no legal status under California State law. The Nevada Natural Heritage Program and the California Native Plant Society maintain prioritized lists of sensitive plants and animals and plants, respectively. The general distribution and habitat of all such sensitive species along the Truckee River and associated lakes and reservoirs potentially affected by changes in reservoir management are presented in table 3.69. Eighty-eight special status species known or likely to occur in the study area would not be affected by any alternative and are summarized in the Biological Resources Appendix.

Cui-Ui

I. Affected Environment

A. Status and Distribution

Cui-ui, were abundant in Pyramid Lake and in the adjacent Winnemucca Lake at the beginning of the 20th century. As water diversions for M&I and agricultural uses, especially the Newlands Project, were developed, Truckee River inflow to Pyramid Lake diminished substantially. During the 1930s, the elevation of Pyramid Lake dropped rapidly and a large delta formed at the mouth of the Truckee River, making it frequently impassable to the stream spawning cui-ui. Winnemucca Lake dried up at this time as well. By the early 1940s, the Pyramid Lake strain of LCT had been extirpated. In most years after the 1930s, neither cui-ui nor LCT were able to gain access to the river for spawning. By 1967, Pyramid Lake was nearly 80 feet lower than in 1900. FWS and the State of Nevada listed the cui-ui as endangered in 1967. A Recovery Plan was approved in 1978, with the most recent revision completed in 1992.

Because cui-ui may live as long as 45 years or more (Scoppetonne et al., 1996), it has been able to take advantage of the occasional high water years to reproduce. From 1950 to 1979, cui-ui produced large numbers of young in only two years (1950 and 1969) (Scoppettone and Vinyard, 1991). Successful spawning occurred in 14 years from 1980 to 2003. This improvement is attributed to cooperative management efforts among FWS, Reclamation, and the Pyramid Tribe; construction of Marble Bluff Dam and subsequent design improvements; the dedication of Stampede Reservoir storage to cui-ui and LCT; wet years and flow management during drought years that support spawning under less flows; and, reduced diversions to the Newlands Project over the last two decades. Table 3.70 presents recent cui-ui adult passage through Marble Bluff Dam.

Table 3.70—Recent cui-ui adult passage through Marble Bluff Dam

Year	Estimated spawners	Year	Estimated spawners
1994	66,000	2001	No spawning run
1995	112,000	2002	39,000
1996	172,000	2003	160,000
1997	307,000	2004	169
1998	492,000	2005	1,356,000
1999	584,000	2006	956,000
2000	183,000		

Rounded to nearest thousand (except for 2004).

B. Life History

The lake-dwelling cui-ui is an obligatory stream spawner in the Truckee River. The size of the spawning run is influenced by the size and year-class structure of the adult population, river access, and inflow. When lake elevation and spring inflows have been high, spawning runs have been large (Buchanan and Coleman, 1987). The spawning migration begins in April or May, depending on inflow, river access and water temperatures and continues for 4 to 8 weeks. Most of the spawners enter the river during a 1- to 2-week period (Buchanan and Coleman, 1987).

Historically, cui-ui may have spawned in the lower 43 miles of the Truckee River. Most now spawn downstream from Numana Dam, but cui-ui migrate beyond Numana Dam during high spawning runs. More than an estimated 250,000 spawners have been observed at Wadsworth, and larvae have been captured just downstream from Wadsworth (Heki, 2004). Cui-ui spend up to 16 days in the river: 1 to 11 days acclimating to the river environment before spawning and 1 to 5 days after spawning is initiated. Once an adult has finished spawning, it moves back to the lake within hours and does not return to the river until the following spring at the earliest (Scoppettone et al., 1986).

Like other suckers, cui-ui spawn in groups, depositing eggs over a broad area of predominantly gravel substrate in water 0.8 to 4.0 feet deep, where water velocity is 1 to 2 feet per second (Buchanan and Coleman, 1987). Fertilized eggs hatch in 1 to 2 weeks depending on water temperature. Embryo survival decreases when daily maximum temperatures exceed 63 ºF. After eggs hatch, the yolk-sac larvae spend 5 to 10 days in the gravel before they emerge. Cui-ui are considered yolk-sac larvae from the time they hatch until the yolk-sac is absorbed and feeding begins, about two weeks. Upon emergence, most larvae are swept passively downstream to the lake, although a few may find refuge in the river's backwaters for a month or two. The mouths of larvae do not open until about 16 days after hatching (Bres, 1978), and emigrating larvae usually retain their yolk sacs. The timing of mouth opening corresponds with entry into the lake.

Upon reaching the lake, larvae remain in the shallow littoral zone feeding on zooplankton. In late summer they disperse into deeper water, where both young-of-the-year juveniles and adults feed on zooplankton and benthic invertebrates. Although juveniles and adults are commonly found near the lake bottom in 50 to 100 feet of water throughout the year, their movement in Pyramid Lake is not well known (Buchanan and Coleman, 1987).

C. Management

1. Flow Regimes for Stampede Reservoir Storage

The completion of Stampede Dam and Reservoir on the Little Truckee River contributed to reestablishing Truckee River flows suitable for cui-ui (FWS, 1992a). Since 1976, FWS has used water from Stampede Reservoir to adjust volume and timing of flows to enhance cui-ui spawning runs and to maintain water temperatures suitable for egg incubation. In 1982, the U.S. District Court for the District of Nevada affirmed the

Secretary's authority by ruling that the Secretary was to use "…the waters stored in Stampede Reservoir for the benefit of the Pyramid Lake fishery until such time as the cui-ui and LCT are no longer classified as threatened or endangered, or until sufficient water becomes available from other sources to conserve the cui-ui and LCT." The U.S. Ninth Circuit Court of Appeals affirmed this decision, and the U.S. Supreme Court declined to review the case. This gave cui-ui its only assured water supply.

Early management guidelines established flow regimes for the lower river (FWS, 1992a). Minimum management spawning flows during May and June were set at 1,000 cfs (approximately 60,000 acre-feet per month. Flows were not to exceed 2,500 cfs to reduce the potential for killing eggs and yolk-sac larvae by scouring and to enable adult movement (Buchanan, 1987; Buchanan and Burge, 1988; Buchanan and Strekal, 1988). From January through April, 60,000 acre-feet of attraction flows were required.

In the mid-1990s, FWS-funded research led to the development of four variable flow recommendations for the Truckee River. Research conducted by The Nature Conservancy indicated that flow management that varies across seasons and across years was the optimum solution for meeting all ecosystem needs in a naturally variable riverine system with variable availability of water for environmental flows. The Nature Conservancy developed four flow management regimes for the lower Truckee River in 1995 (Gorley, 1996). FWS implemented these flow regimes using water stored in Stampede Reservoir in excess of fish water to enhance riparian recruitment, channel maintenance; aquatic and riparian ecosystem maintenance; and a survival flow regime for use as an emergency plan during extremely dry years. These flow regimes used by FWS from 1995 through 2000 resulted in substantial improvement in the riparian forest downstream from Derby Diversion Dam and in other sites along the Truckee River (TRIT, 2003).

Beginning in 2002, FWS, in cooperation with the Pyramid Tribe, replaced these four flow regimes by six-flow regimes. The six-flow regimes were intended to release less water in the spring and more water in late summer and fall, resulting in measured releases of water in the Truckee River over the entire year. The strategy was designed to more closely mimic a natural river system while protecting habitat for both cui-ui and LCT. A successful cui-ui spawning event was supported in 2002 during an extreme dry year using only 23,000 acre-feet of storage water.

Such flow patterns also have proven effective in maintaining riparian trees and shrubs that established in the 1980s through droughts in the early and late 1990s (Rood et al., 2003). The six-flow regime recommendations are intended to provide the flexibility to implement an adaptive management strategy for the Truckee River. The recommended flows, which currently use Stampede (and a portion of Prosser Creek) Reservoir storage, vary according to the amount of water available in the system at any given time (table 3.39). Additional discussion of the six-flow regime is provided in "Fish in Truckee River and Affected Tributaries" and in the Biological Resources Appendix.

These ecosystem flows benefit both cui-ui and LCT, either directly or indirectly by maintaining or enhancing riparian vegetation, which provides shade along the river, thereby reducing the volume of water needed to maintain suitable temperatures for spawning and incubation. Alternatives presented in this EIS/EIR would not alter the way in which FWS manages the six-flow regimes; the alternatives, however, may indirectly affect the amount of water available and the flow regime that can be achieved in any given year. Flow regimes 1, 2, and 3 are specifically designed to support cui-ui spawning runs.

2. Recovery Plan

The 1992 Revised Recovery Plan sets out four broad categories of conservation measures to improve and protect cui-ui spawning, incubation, and rearing habitat: (1) increase volume and improve timing of inflow to Pyramid Lake; (2) rehabilitate the lower Truckee River; (3) achieve water quality standards; and (4) improve fish passage in the lower Truckee River. Much progress has been made in restoring the lower Truckee River as evidenced by implementation of the various flow regimes for management of Stampede Reservoir storage (Rood et al., 2003). Progress also has been made in improving fish passage at Marble Bluff Dam. Fish passage over the Truckee River delta has been improved recently because of rising Pyramid Lake elevations. Recent droughts, however, are again exacerbating delta conditions at the terminus of the Truckee River (Heki, 2004).

3. Fish Passage

Three major structures impede fish movements between Pyramid Lake and Derby Diversion Dam: Marble Bluff Dam, 3 miles upstream; Numana Dam, 8.3 miles upstream; Derby Diversion Dam itself, 34 miles upstream. There are also six small rock structures within the Pyramid Lake Reservation that impede passage.

a. Marble Bluff Dam

Reclamation constructed this dam and fish passageway in 1975 to reduce river headcutting and to provide passage of fish from the lake to the lower river. FWS manages the fish facility at Marble Bluff Dam, while Reclamation maintains the dam and fish lock. A state-of-the-art lock system at the dam provides a means of capturing fish as well as passage over the dam for fish which migrate via the river. The facility also includes a clay-lined fishway, with a capacity of 50 cfs that provides a 3-mile-long passageway to the Truckee River for both cui-ui and LCT to spawn and return to the lake when they are unable to migrate upriver either because of low river or lake elevations. The fishway terminates at the river though a bypass ladder installed in 1998 (Heki, 2004). Fish in the fishway can also be run through a fish handling building for sampling.

Flooding in January 1997 damaged the existing rock armoring of the dam, and Reclamation in conjunction with the Pyramid Tribe and FWS, repaired it in 1998. The 1997 flood caused extensive scouring in the channel downstream from the dam, altering the river hydraulics. A rock armored channel was constructed in 1998 to improve fish access to the fish lock. Reclamation, FWS and the Pyramid Tribe completed work on a major modification to the fish passage facility in 1998. The modifications provide a more efficient and reliable passage for cui-ui from Pyramid Lake to Truckee River. The modified facility handles approximately 10 times the number of fish per hour than the earlier design.

b. Numana Dam

This dam was constructed in 1917 to divert Truckee River water for agricultural purposes to the Pyramid Lake Indian Reservation. It is located about 8 miles off the Pyramid Lake shoreline. The fish ladder and screens were retrofitted in 1976 to facilitate fish passage but design limitations create a severe bottleneck for fish. By 2000 the screens were badly corroded and not functional. In 2001, COE began investigating a range of alternatives including a fish passage channel and removal of the dam. Currently, cui-ui are not provided access upstream of Numana Dam because adult and larval entrainment into the canal occurs. Numana Dam is a complete impediment to cui-ui and, therefore, impedes spawning success.

4. Derby Diversion Dam

This dam was completed in 1905. The dam, an integral part of the Newlands Project, diverts Truckee River water into the Truckee Canal for irrigation of the Truckee Division lands and for supplemental storage in Lahontan Reservoir on the Carson River for the Carson Division of the Newlands Project. A fish ladder was installed at Derby Diversion Dam in 1908, but the ladder is no longer functional. In 2002, Reclamation completed construction of the Derby Diversion Dam Fish Passage Project to provide passage to cui-ui and LCT past Derby Diversion Dam. The fishway is 935 feet long; large boulders in the fishway can be adjusted to control the velocity of water through the channel and to provide a resting spot for fish.

II. Environmental Consequences

A. Introduction

For cui-ui, the analysis of alternatives focuses on habitat conditions related to spawning. The following indicators were evaluated:

- Annual average inflow to Pyramid Lake
- Frequency (number of years) that flow regime 1, 2, or 3 is achieved in the lower Truckee River (between Numana and Marble Bluff Dams) from April through June
- Relative amounts of riparian vegetation along the lower Truckee River

B. Summary of Effects

1. Average Annual Inflow to Pyramid Lake

Operations model results show that, under TROA, average annual inflow to Pyramid Lake is greater than under No Action or current conditions. Greater inflow would benefit cui-ui by maintaining Pyramid Lake at a higher elevation, which, in turn, would enhance lake habitat and river access. Under both No Action and LWSA, average annual inflow to Pyramid Lake are less than under current conditions, adversely affecting cui-ui. Table 3.71 summarizes these effects.

Table 3.71—Summary of effects: average annual inflow (acre-feet) to Pyramid Lake (+ = significant beneficial effect, - = significant adverse effect)

	Compared to current conditions			Compared to No Action	
	No Action	**LWSA**	**TROA**	**LWSA**	**TROA**
Net change	-	-	-	-	+

2. Frequency that Flow Regime 1, 2, or 3 is Achieved in the Lower Truckee River from April through June

Overall, operations model results show that flow regimes 3 and greater are achieved about as frequently under LWSA and TROA as under No Action and as frequently under No Action, LWSA, and TROA as under current conditions. Under TROA, however, flow regime 1 or 2 is achieved more frequently in May and June, which would be a significant beneficial effect under TROA. Table 3.72 summarizes these effects.

Table 3.72—Summary of effects: achievement of flow regime 1, 2, or 3 (+ = significant beneficial effect)

Month	Compared to current conditions			Compared to No Action	
	No Action	**LWSA**	**TROA**	**LWSA**	**TROA**
April	No effect		No effect	No effect	No effect
May			+		+
June			+		+

3. Relative Amounts of Riparian Habitat Along the Lower Truckee River

A significant beneficial effect on riparian habitat along the lower Truckee River in median, dry, and extremely dry hydrologic conditions would occur under TROA compared to both No Action and current conditions. Cui-ui would be likely to indirectly benefit from cooler water temperatures as a result of shading by riparian vegetation. Significant beneficial effects on riparian habitat along the lower Truckee River in wet, median, and extremely dry hydrologic conditions would occur under No Action and LWSA when compared to current conditions. No effect would occur under LWSA when compared to No Action. Table 3.73 summarizes these effects.

Table 3.73—Summary of effects: relative amounts of riparian habitat along the lower Truckee River (+ = significant beneficial effect, - = significant adverse effect)

Hydrologic condition	Compared to current conditions			Compared to No Action	
	No Action	LWSA	TROA	LWSA	TROA
Wet	+	No effect		No effect	
Median	+	+	+	No effect	+
Dry	No effect	+			+
Extremely dry	+	+	+		+

C. Average Annual Inflow to Pyramid Lake

1. Method of Analysis

Operations model results were used to calculate average annual inflow to Pyramid Lake under current conditions and each alternative over the modeled 100-year period, based on flow at Nixon.

2. Threshold of Significance

An objective of the Cui-ui Recovery Plan is to increase Truckee River inflow to Pyramid Lake to enhance river access and habitat for spawning. Any change in inflow was considered significant.

3. Model Results

Table 3.74 presents operations model results for average annual inflow to Pyramid Lake.

Table 3.74—Average annual inflow (acre-feet) to Pyramid Lake

Current conditions	No Action	LWSA	TROA
495,430	490,940	490,380	500,670

4. Evaluation of Effects

a. No Action

Operations model results show that, under No Action, average annual inflow to Pyramid Lake is 4,490 acre-feet less than under current conditions, which would result in a significant adverse effect.

b. LWSA

Average annual inflow to Pyramid Lake under LWSA is 560 acre-feet less than under No Action and 5,050 acre-feet less than under current conditions, which would result in a significant adverse effect under LWSA compared to No Action or current conditions.

c. TROA

Under TROA, average annual inflow to Pyramid Lake is 9,730 acre-feet greater than under No Action and 5,240 acre-feet greater than under current conditions. Greater inflow is due to the conversion of M&I Credit Water to Fish Credit Water, in combination with increased return flow of groundwater from the sewage effluent reuse program. Water Quality Water accounts for the additional difference between TROA and current conditions. Greater average annual inflow would increase the elevation of Pyramid Lake. Greater inflow would result in improved adult and juvenile lake rearing habitat; improved adult migration conditions across Truckee River delta and into the lower Truckee River; and greater flows in spawning habitat in the lower Truckee River. The greatest benefits would occur in dry and very dry years, which are the most critical for cui-ui survival. These would be significant beneficial effects under TROA.

5. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under TROA. A significant beneficial effect for cui-ui would occur under TROA because annual average inflow to Pyramid Lake would be greater.

D. Frequency that Flow Regime 1, 2, or 3 is Achieved in the Lower Truckee River from April through June

1. Method of Analysis

Operations model results were used to calculate the frequency (number of years over the 100-year modeled period) that the average monthly flows for regime 1, 2, or 3 are achieved, based on flow at Nixon, from April through June, the period of cui-ui spawning.

2. Threshold of Significance

The number of years that flow regime 1, 2, or 3 is achieved from April though June was compared. It was assumed that flow regime 1 would be more beneficial for cui-ui than flow regime 2, and flow regime 2 would be more beneficial than flow regime 3.

3. Model Results

Table 3.75 presents operations model results for the frequency (number of years) that flow regime 1, 2, or 3 is achieved in the lower Truckee River from April through June.

Table 3.75—Frequency (number of years) that flow regime 1, 2, or 3 is achieved in the lower Truckee River from April through June

Flow regime (flow recommendation)	Current conditions	No Action	LWSA	TROA
April				
1 (flow ≥ 590 cfs)	68	64	64	62
2 (flow ≥ 490 cfs)	8	9	8	11
3 (flow ≥ 420 cfs)	5	5	6	4
April total (1 + 2 + 3)	81	78	78	77
May				
1 (flow ≥ 1000 cfs)	57	56	56	55
2 (flow ≥ 800 cfs)	7	7	7	11
3 (flow ≥ 600 cfs)	10	12	12	7
May total (1 + 2 + 3)	74	75	75	73
June				
1 (flow ≥ 800 cfs)	48	48	48	49
2 (flow ≥ 600 cfs)	8	8	8	14
3 (flow ≥ 500 cfs)	13	12	12	5
June total (1 + 2 + 3)	69	68	68	68

4. Evaluation of Effects

a. No Action

Operations model results show that, under No Action, flow regimes 3 and greater are achieved 3 fewer times in April, 1 more time in May, and 1 fewer time in June than under current conditions. These differences would be unlikely to have a significant effect on the cui-ui population.

b. LWSA

Under LWSA, flow regimes 3 and greater are achieved as frequently as under No Action or current conditions except for two minor differences. These differences would be unlikely to have an effect on the cui-ui population.

c. TROA

Under TROA, flow regimes 3 and greater are achieved 1 fewer time in April and 2 fewer times in May than under No Action, which would be unlikely to have a significant adverse effect. Flow regimes 2 and greater, however, are achieved 3 percent more frequently in May and 7 percent more frequently in June. This moderate difference likely would benefit cui-ui spawning and, therefore, would be a significant beneficial effect when TROA is compared to No Action.

Under TROA, flow regimes 3 and greater are achieved 4 fewer times in April and 1 fewer time in May and June than under current conditions. Flow regime 2 and greater, however, are achieved only 3 percent less frequently in April, 2 percent more frequently in May, and 7 percent more frequently in June. This moderate difference likely would benefit cui-ui spawning and, therefore, would be a significant beneficial effect when TROA is compared to current conditions.

5. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under any of the alternatives. A significant beneficial effect for cui-ui would occur under TROA because flow regimes 1 and 2 would be achieved more frequently in May and June than under No Action or current conditions.

E. Relative Amounts of Riparian Habitat Along the Lower Truckee River

See "Riparian Habitat and Riparian-Associated Wildlife" for discussions of method of analysis and threshold of significance. For the cui-ui analysis, only riparian habitat downstream from Derby Diversion Dam was evaluated.

1. Evaluation of Effects

a. No Action

Compared to current conditions, a significant beneficial effect on riparian habitat along the lower Truckee River would occur under No Action in wet, median, and extremely dry conditions. Cui-ui would be likely to indirectly benefit from cooler water temperatures as a result of shading by riparian vegetation. See more detailed discussion in "Riparian Habitat and Riparian-Associated Wildlife."

b. LWSA

When compared to No Action, riparian habitat along the lower Truckee River would not be affected under LWSA. Compared to current conditions, a significant beneficial effect on riparian habitat along the lower Truckee River in median and extremely dry hydrologic conditions would occur under LWSA. Cui-ui would be likely to indirectly benefit from cooler water temperatures as a result of shading by riparian vegetation. See more detailed discussion in "Riparian Habitat and Riparian-Associated Wildlife."

c. TROA

When compared to both No Action and current conditions, a significant beneficial effect on riparian habitat in median, dry, and extremely dry hydrologic conditions would occur under TROA. Cui-ui would be likely to indirectly benefit from cooler water temperatures as a result of shading by riparian vegetation. See more detailed discussion in “Riparian Habitat and Riparian-Associated Wildlife.”

2. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under TROA. Enhancing riparian habitat along the lower Truckee River, thereby reducing water temperatures through shading effects, would be a significant beneficial effect under TROA.

Lahontan Cutthroat Trout

I. Affected Environment

A. Status and Distribution

Lahontan cutthroat trout, is an inland subspecies of cutthroat trout endemic to the Lahontan basin of northern Nevada, eastern California, and southern Oregon. It was listed by FWS as endangered in 1970 (35 FR 13520, August 25, 1970) and later reclassified as threatened in 1975 to facilitate management and allow regulated angling (40 FR 29864, July 16, 1975). A recovery plan was issued in 1995. There is no designated critical habitat. LCT has been introduced into habitats outside its native range, consistent with the recovery plan.

The LCT Recovery Plan estimated that less than 0.2 percent of lake habitat and about 2.2 percent of stream habitat in the Truckee River basin were occupied by LCT (FWS, 1995b). The only remaining indigenous population resides in Independence Lake and the main inlet tributary Independence Creek (Peacock et al., 1999). LCT within the Truckee River basin is included in the Western Lahontan Basin population segment, one of three population segments of LCT. Within the Truckee River basin, there are currently seven small headwater tributaries with a total of 8 miles that support self-sustaining river populations. These populations are found in Independence Creek, Pole Creek, Upper Truckee River, Bronco Creek, Hill Creek, and West Fork Gray Creek. There are two lake populations in Pyramid and Independence Lakes. Only Independence Lake has a naturally reproducing population. Pyramid Lake has a hatchery-maintained population.

LCT occupied about 360 miles of suitable stream habitat and 284,000 acres of lake habitat within the Truckee River basin prior to the 1860s (Gerstung, 1986). The largest populations of LCT occurred in Pyramid Lake and Lake Tahoe, where the fish was a major food source, along with the cui-ui, for local Indians.

1. Pyramid Lake

By 1944, the original Pyramid Lake LCT population was extirpated after it lost access to its Truckee River spawning grounds due to Derby Diversion Dam, pollution, commercial harvest and exotic fish introductions into the main Truckee River system (Sumner, 1940; Gerstung, 1988; Knack and Stewart, 1984; Behnke, 1992). Hatchery stocking developed a popular LCT sport fishery at Pyramid Lake. Four strains of LCT (Heenan, Walker, Summit and Independence Lakes) were used for stocking into Pyramid Lake until the 1980s (Coleman and Johnson, 1988). Since the early 1980s, LCT eggs have been taken exclusively from Pyramid Lake spawners and reared for release (FWS, 1995b).

2. Lake Tahoe

The native Lake Tahoe LCT population was extirpated in 1939 as a result of damage to spawning tributaries from pollution, logging, diversions and dams; overfishing; and the inability to compete with the introduced lake trout (Gerstung, 1986, 1988; Behnke, 1992).

3. Independence Lake

Independence Lake has the only self-sustaining lake LCT population in the Truckee River basin. This population is genetically unique (Cowan, 1988; Bartley and Gall, 1993) and is vulnerable to extinction (FWS, 1995b). The lake supports a small catch-and-release fishery, and historically supported spawning runs of 2,000 to 3,000 fish (Welch, 1929). By 1960, the population had declined to less than 100 spawners per year (Gerstung, 1988), despite many attempts to supplement this population with hatchery-reared native Independence Lake LCT stock. The population decline is thought to be the result of competition with non-native kokanee salmon in the lake and brook trout in the stream. Additionally, a sand/silt delta has formed where Independence Creek enters the lake, which blocks LCT spawning runs into the creek when lake storage is less than 7,500 acre-feet (FWS, 1995b).

B. Life History

River- and lake-adapted forms of LCT have different behavior, ecology and habitat use. Optimal river habitat is characterized by the following: (1) clear cold water with an average maximum summer temperature of less than 22 ºC (72 ºF), and relatively stable summer temperature regime averaging about 13 ºC (55 ºF) plus or minus 4 ºC (7 ºF); (2) pools in close proximity to cover and velocity breaks to provide hiding cover and spawning areas; (3) well vegetated, stable stream banks; (4) 50 percent or more of stream area providing cover; and (5) a relatively silt free rocky substrate in riffle-run areas (FWS, 1995b). Optimal lake habitat is characterized by: (1) clear, cool/cold water with an average summer surface layer temperature of less than 72 ºF; (2) a surface layer with a pH of 6.5 to 8.5 and dissolved oxygen content of less than 8 milligrams per liter (mg/L); and (3) access to spawning tributaries.

LCT is an obligate stream spawner. Spawning occurs from February through July, depending on flow, elevation, and water temperatures. Historically, populations in Pyramid and Winnemucca Lakes migrated more than 100 miles up the Truckee River through Lake Tahoe to headwaters in its tributaries to spawn (Sumner, 1940; La Rivers, 1962). The upper river provided the cool water temperatures needed for spawning and fry and for juvenile rearing. The most important LCT spawning habitat in the Truckee River was upstream of Verdi, Nevada.

Providing spawning opportunities and permanent rearing habitat for LCT in the lower reaches of the Truckee River has been unachievable because of seasonal high water temperatures, lack of spawning habitat, high sediment loads, variable flows downstream from diversions, and lack of passage at Derby Diversion Dam. Cooperative efforts are ongoing to improve riparian and riverine habitat. Spawning downstream from Derby Diversion Dam is not an objective for LCT because they probably never spawned (or reared) in the lowest reaches.

Access to historic spawning habitat in the upper Truckee River is blocked by more than 10 dams and water diversion structures (TRIT, 2003). Some progress in improving passage has been made with the renovation of Marble Bluff Dam (1999) and completion of the Derby Diversion Dam fish ladder (2002).

Trout populations in the Truckee River basin are predominantly non-native. Rainbow, brook, brown, and lake trout as well as kokanee salmon have been stocked into Truckee basin waters over the last century (Peacock et al., 1999). Most of these species compete with LCT and are at least partially responsible for extirpation of the native strain that occupied the Truckee River basin. Rainbow trout, a closely related species, spawns at the same time and in the same habitats as LCT, with which it can hybridize (TRIT, 2003). Kokanee and lake trout are particularly detrimental to lake LCT populations. In lakes, kokanee successfully compete for zooplankton, a major LCT food source (Behnke, 1992), and lake trout are efficient predators of LCT.

C. Management

Fish passage and flow management described for cui-ui also apply to LCT restoration.

1. Recovery Plan

In 1995, FWS released the LCT Recovery Plan encompassing six river basins within LCT historic range, including the Truckee River basin. The plan identified five conditions contributing to the decline and affecting the potential for recovery of LCT in the Truckee River basin: (1) reduction and alteration of streamflow and discharge; (2) alteration of stream channels and morphology; (3) degradation of water quality; (4) reduction of Pyramid Lake elevation and concentration of chemical components; and (5) introductions of non-native fish species. Recently, a Short-Term Action Plan for LCT in the Truckee River Basin was released (TRIT, 2003). This plan focuses on gathering information about habitat requirements and implementing demonstration projects and research.

2. Hatchery Stocking

In addition to various habitat restoration measures, CDFG, NDOW, FWS, and the Pyramid Tribe are actively engaged in LCT stocking efforts in the Truckee River Basin. Since the extirpation of the original Pyramid Lake strain of LCT, the fishery has been maintained by a hatchery stocking program currently operated by the Pyramid Lake Paiute Tribal Fishery Program and FWS. Several strains of LCT from other waters were planted in Pyramid Lake to redevelop the fishery. The fishery is currently sustained by capturing LCT during the spawning period, taking spawn, and hatching the fish at the Numana Tribal Fish Hatchery and the Lahontan National Fish Hatchery (LNFH). Most

LCT are captured at the Sutcliffe spawning facility. FWS has funded genetic research on this species to improve understanding of the origins of out-of-basin populations. Based on this research (TRIT, 2003), LNFH has developed a brood stock of the Pilot Peak strain, believed to be original Pyramid Lake stock. FWS is using this strain in the Truckee River and Fallen Leaf Lake.

The LCT recovery program has stocked LCT out of its historic range into headwaters tributaries with barriers to protect the LCT from hybridization with nonnative rainbow trout since 1996. Six streams with a total length of 30 miles have been stocked.

In 2003, about 30,000 catchable sized LCT were released in the Truckee River between Tahoe City and Truckee. The purpose of this effort is to gain information to improve understanding of the conservation needs of LCT in the Truckee River Basin (Heki, 2004). This is a small part of a broader effort to reestablish LCT in the watershed.

In 2003, NDOW and the Pyramid Tribe cooperated on the release of 2,200 mature LCT between Fisherman's Park in Reno upstream to Crystal Peak Park in Verdi. The introduction of these fish marked the beginning of a 5-year study to determine the feasibility of restoring LCT to the Truckee River. Fish collected during the spawning run at Pyramid Lake ranged from 18 to 24 inches long. The fish will be monitored to determine spawning locations and potential for spawning success (http://ndow.org/fish/forecast/west.shtm).

In the lower Truckee River, NDOW, FWS, and the Pyramid Tribe are conducting an ongoing project to assess movement patterns and survival of stocked LCT. A total of about 50,000 8-inch LCT are stocked in the river annually (Heki, 2004). In 2006, about 100,000 LCT eggs will be incubated at Pyramid Lake or in the Truckee River or its tributaries and fry survival and movement will be studied (NDOW, 2006).

3. Riparian Vegetation Restoration

Narrow bands of Fremont cottonwood with some sandbar and black willow became established in 1983 and 1987 along the lower Truckee River as an unplanned consequence of flow regulation directed toward the spawning needs of the cui-ui (Rood et al., 2003). These stands of cottonwoods and willows provided the basis for streamflow prescriptions designed to promote seedling establishment from 1995 through 2000 (TRIT, 2003). These flows enabled further seedling establishment. An important feature of these flows is a gradual decrease of flows during the critical seedling establishment period.

The establishment of riparian forests in the lower Truckee River and the increased understanding of flow requirements that promote seedling establishment and survival has tremendous consequences for re-establishing LCT in the lower Truckee River. Re-establishment of cottonwoods and willows has altered sediment scour and deposition resulting in a narrower deeper channel. The deepening of the channel along with shading has resulted in cooler water temperatures, and reduced erosion and sedimentation. In 1999, in contrast to prior years, trout were observed in the lower Truckee River throughout the summer (Rood et al., 2003).

II. Environmental Consequences

A. Introduction

This analysis focuses on how modifying operations of Truckee River reservoirs would affect the habitat and management efforts for LCT. Two recovery criteria set forth in the 2003 Short-Term Action Plan are relevant to the operations alternatives considered in this study: (1) Truckee River water is managed to support LCT migration, life history, and habitat requirements and (2) threats to LCT and its habitat have been reduced or modified to where they no longer represent a threat of extinction or irreversible population decline.

The following three indicators were selected to analyze potential effects:

- Average annual inflow to Pyramid Lake
- Relative amounts of riparian vegetation along the lower Truckee River
- LCT spawning access to Independence Creek in dry and extremely dry hydrologic conditions

B. Summary of Effects

Operations model results show that, under TROA, average annual inflow to Pyramid Lake is greater than under No Action or current conditions. Greater inflow would benefit LCT by maintaining Pyramid Lake at a higher elevation, which would enhance lake habitat and river access. Under both No Action and LWSA, average annual inflow to Pyramid Lake is lower than under current conditions, which would adversely affect LCT. Table 3.71 summarizes these effects.

Significant beneficial effects to riparian habitat along the lower Truckee River in median, dry, and extremely dry hydrologic conditions would occur under TROA. LCT would be likely to indirectly benefit from cooler water temperatures as a result of shading by riparian vegetation. Significant beneficial effects to riparian habitat along the lower Truckee River in wet, median, and extremely dry hydrologic conditions would occur under LWSA and No Action. The effect under LWSA would be the same as under No Action. Table 3.66 summarizes these effects.

TROA would result in a significant beneficial effect by providing additional access to Independence Creek in August, when compared to current conditions, and in July and August, when compared to No Action. Under both No Action and LWSA, a significant adverse effect compared to current conditions would occur in July and August. In addition, TROA provides that CDFG can direct TMWA to provide and maintain a fish channel through the Independence Creek delta should storage in Independence Lake drop below 7,500 acre-feet. This condition would not apply under No Action or current conditions. Table 3.76 summarizes these effects.

Table 3.76—Summary of effects: LCT spawning access to Independence Creek in dry and extremely dry hydrologic conditions (+ = significant beneficial effect, - = significant adverse effect)

<table>
<tr><th></th><th colspan="3">Compared to current conditions</th><th colspan="2">Compared to No Action</th></tr>
<tr><th>Spawning period</th><th>No Action</th><th>LWSA</th><th>TROA</th><th>LWSA</th><th>TROA</th></tr>
<tr><td>May</td><td colspan="3" rowspan="2">No effect</td><td rowspan="4">No effect</td><td rowspan="2">No effect</td></tr>
<tr><td>June</td></tr>
<tr><td>July</td><td>-</td><td>-</td><td>No effect</td><td>+</td></tr>
<tr><td>August</td><td>-</td><td>-</td><td>+</td><td>+</td></tr>
</table>

C. Average Annual Inflow to Pyramid Lake

See discussions of method of analysis, threshold of significance, model results, and evaluation of effects in “Cui-ui.” The exception is that for the threshold of significance, the LCT Recovery Criteria (TRIT, 2003) for Pyramid Lake calls for obtaining water through water right purchases or other means to protect a secure and stable Pyramid Lake ecosystem and meet life history and habitat requirements of LCT. Also, no mitigation would be required because no significant adverse effects would occur under TROA. TROA would provide a significant beneficial effect for LCT by increasing the amount of average annual inflow to Pyramid Lake and improving riverine habitat through management of dedicated water.

D. Relative Amounts of Riparian Vegetation Along the Lower Truckee River

See discussions of method of analysis, threshold of significance, and model results in “Riparian Habitat and Riparian-Associated Wildlife.”

1. Evaluation of Effects

a. No Action

A significant beneficial effect on riparian habitat along the lower Truckee River in wet, median, and extremely dry hydrologic conditions would occur under No Action. LCT would be likely to indirectly benefit from cooler water temperatures as a result of shading by riparian vegetation. See the more detailed discussion of effects in "Riparian Habitat and Riparian-Associated Wildlife."

b. LWSA

Under LWSA, the effect on riparian habitat along the lower Truckee River would be the same as under No Action.

c. TROA

A significant beneficial effect on riparian habitat in median, dry, and extremely dry hydrologic conditions would occur under TROA when compared to both No Action and current conditions. LCT would be likely to indirectly benefit from cooler water temperatures as a result of shading by riparian vegetation. See the more detailed discussion of effects in "Riparian Habitat and Riparian-Associated Wildlife."

2. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under TROA. TROA would provide a significant beneficial effect for LCT by enhancing riparian habitat along the lower Truckee River, thereby reducing water temperatures through shading effects.

E. Access to Independence Creek for Spawning LCT

1. Method of Analysis

Operations model results were used to determine Independence Lake storage under current conditions and the alternatives. All water years were examined, but only dry and extremely dry hydrologic conditions are highlighted because storage does not fall to 7,500 acre-feet in other hydrologic conditions.

2. Threshold of Significance

LCT access to the spawning habitat in Independence Creek is blocked by the delta when Independence Lake storage is at or below 7,500 acre-feet. Any change in the number of times that storage is at or below 7,500 acre-feet was considered significant.

3. Model Results

Table 3.77 presents operations model results for the differences in the number of years (out of 100) that Independence Lake storage is at or below 7,500 acre-feet during the LCT spawning period.

Table 3.77—Difference in number of years (out of 100) that Independence Lake storage is at or below 7,500 acre-feet during the LCT spawning period

	Compared to current conditions			Compared to No Action	
	No Action	**LWSA**	**TROA**	**LWSA**	**TROA**
May	0	0	0	0	0
June	0	0	0	0	0
July	+1	+1	0	0	-1
August	+1	+1	-1	0	-1

4. Evaluation of Effects

a. No Action

Operations model results show that, under No Action, storage in Independence Lake falls below 7,500 acre-feet one more time than under current conditions in July and August. Because of the extreme vulnerability of the LCT population in Independence Creek, any potential loss of access to its spawning habitat would be a significant adverse effect.

b. LWSA

Operations model results and effects under LWSA are the same as under No Action.

c. TROA

Under TROA, Independence Lake falls below 7,500 acre-feet one fewer time during each of July and August than under No Action. There are no differences in May and June. Independence Lake falls below the 7,500 acre-feet threshold one fewer time than under current conditions in August; there are no differences in May, June, or July. TROA provides that CDFG can direct TMWA to provide and maintain a fish channel through the Independence Creek delta should Independence Lake storage drop below 7,500 acre-feet. This condition would not apply under No Action or current conditions. The additional opportunities to provide spawning access for the Independence Lake LCT population would be significant beneficial effects under TROA.

5. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under TROA. TROA would provide a significant beneficial effect for LCT by reducing the number of times that Independence Lake falls below 7,500 acre-feet and by providing the ability for CDFG to direct TMWA to provide and maintain a fish channel though the Independence Creel delta should storage fall below 7,500 acre-feet.

Bald Eagle

I. Affected Environment

The threatened bald eagle historically nested at Pyramid Lake and Lake Tahoe (Cantrell, 1989).[6] Bald eagles were last known to nest at Pyramid Lake in 1866 (Alcorn, 1988). Since 1997 bald eagles have nested at Emerald Bay along the southwest part of Lake Tahoe (Jurek, 2003). From 2001 to 2003 bald eagles attempted to nest near Marlette Lake, just inland from the east central shore of Lake Tahoe (Espinosa, 2003). Currently, bald eagles nest at Independence Lake and Stampede, Boca, and Lahontan Reservoirs. Other bald eagles could nest within the study area (Jurek, 2003).

In the study area, bald eagles winter at Lake Tahoe, along the Truckee River, and at ice-free lakes and reservoirs. Winter bald eagle surveys at Lake Tahoe recorded 4 to 20 birds annually (U.S. Department of Agriculture, 1998). Lahontan Reservoir is also a bald eagle wintering area. The use of wintering areas is usually traditional, but is also dependent on a reliable food supply (Herron et al., 1985). The arrival of wintering bald eagles in the upper elevations of the study area generally coincides with the peak of kokanee spawning in Taylor Creek and the Little Truckee River, which occurs around mid-October. Wintering bald eagles usually leave the Lake Tahoe area around March (Cantrell, 1989).

Live or dead fish, as well as rodents, small mammals, and other birds may be part of a bald eagle diet in the Great Basin (Ryser, 1985). Most live fish that were observed taken from reservoirs by bald eagles were captured in water more than 6 feet deep (BioSystems, 1992). Eagles cannot reach prey at depths greater than about 2 feet; forages observed over deeper water are likely to be for prey floating on or swimming near the surface. No data exist on the relative importance of native and stocked fish in the diet of nesting bald eagles at Independence Lake and Stampede, Boca, and Lahontan Reservoirs. Both live fish and carrion, are available to bald eagles (BioSystems, 1992). Tui chub and Tahoe sucker, which are common in local reservoirs, are the major prey items for bald eagles at other California reservoirs. In addition, tui chub and Tahoe sucker spawn in shallow waters during the bald eagle nesting season, which makes them vulnerable to bald eagle predation. LCT is also a likely forage species at Independence Lake during the April through June spawning season. Eagles may also take advantage of recently released hatchery fish that die or undergo stress and fish injured by anglers. A variety of non-native fish species have been introduced into Lahontan Reservoir (NDOW, 2004). Of these, crappie, channel catfish and bass have been shown to be an important component of bald eagle diet on Arizona reservoirs (BioSystems, 1992).

[6] The bald eagle was proposed for delisting in 1999. On February 8, 2007, the U.S. Fish and Wildlife Service announced that a court-approved agreement had been reached allowing the agency to make a final determination on the eagle's status no later than June 29, 2007.

II. Environmental Consequences

A. Introduction

The analysis of the effects on bald eagle was based on the analyses of the effects on the primary prey base of bald eagles: fish in lakes and reservoirs. Two indicators were selected for this analysis:

- Fish survival based on minimum storage thresholds (Stampede, Boca, and Lahontan Reservoirs)
- Spring/summer shallow water spawning habitat (Lake Tahoe, Independence Lake, and Lahontan Reservoir)

B. Summary of Effects

Table 3.78 presents a summary of the effects on the primary prey base of bald eagles: fish in lakes and reservoirs.

Table 3.78—Summary of effects: bald eagle prey base
(+ = significant beneficial effect, - = significant adverse effect)

Lake/reservoir	Compared to current conditions			Compared to No Action	
	No Action	LWSA	TROA	LWSA	TROA
Fish survival					
Stampede	+	No effect	+	-	+
Boca	No effect		+	No effect	+
Lahontan	No effect				
Spring/summer shallow water spawning habitat					
Tahoe	No effect				
Independence					
Lahontan					

C. Fish Survival

1. Method of Analysis

See discussion in “Fish in Lakes and Reservoirs.”

2. Threshold of Significance

Bald eagles at Lake Tahoe, Independence Lake, and Stampede, Boca , and Lahontan Reservoirs could be adversely affected if reservoir storage were to fall below current volumes at a sufficient magnitude and frequency to significantly affect fish survival, the eagles' prey base. The significance of differences among the comparisons was based on best professional judgment.

3. Model Results

See model results in "Fish in Lakes and Reservoirs."

4. Evaluation of Effects

See discussion in "Fish in Lakes and Reservoirs."

5. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under TROA. A significant beneficial effect would occur under TROA because storage in Stampede and Boca Reservoirs would fall below the minimum thresholds much less frequently than under No Action or current conditions.

Tahoe Yellow Cress

I. Affected Environment

Tahoe yellow cress, is a Federal candidate plant species and is listed by California as endangered and by Nevada as critically endangered. In the world, Tahoe yellow cress is found only in scattered populations around the shore zone of Lake Tahoe. The highest number of populations is located on the south and west shores where the greatest amount of sandy beach habitat occurs (California State Lands Commission [CSLC], 1998). The Conservation Strategy for Tahoe yellow cress (Pavlik et al., 2002) was developed to guide the conservation and management of Tahoe yellow cress and its habitat. A Memorandum of Understanding (MOU) was signed to ensure implementation of the protective measures identified in the conservation strategy. The parties to this MOU are Tahoe Lakefront Owners Association; League to Save Lake Tahoe; Tahoe Regional Planning Agency; California Department of Fish and Game; California Department of Parks and Recreation; California Tahoe Conservancy, California State Lands Commission; Nevada Division of Forestry; Nevada Division of State Parks; Nevada Division of State Lands; Nevada Natural Heritage Program; FWS; and USFS. Successful implementation of this strategy should obviate listing this species under ESA.

As part of the Conservation Strategy, occurrence data over the period since the plant species was first scientifically described in 1941 were analyzed. The analysis showed that although Tahoe yellow cress had been observed or collected from 51 locations, not all known occurrences have been occupied at the same time. In fact, the species has been shown to occupy nearly 80 percent of its known habitat during the best of conditions and as little as 20 percent during the worst (Pavlik et al., 2002). This is typical of a highly dynamic species that has the ability to expand its population in response to favorable conditions (low lake water) and contract and persist through periods when conditions are less favorable (high lake water).

These data show a strong correlation between lake elevation and Tahoe yellow cress presence. During the drought years 1989 to 1994, when the mean lake elevation was 6,222.8 feet, the plant was present at 89 percent of the known sites on an estimated 1,863 acres. During the wet years from 1995 to 2000, the mean lake elevation was 6227.7 feet, and the plant was present at 32.8 percent of known sites on an estimated 233 acres (Pavlik et al., 2002).

Much Tahoe yellow cress habitat is popular for recreation and associated use, such as facility development and construction, and beach property maintenance (beach raking and clearing) which have been documented as sources of disturbance to the plant and its habitat (TRPA, 1995; CSLC, 1998). The habitat is also subject to various natural physical processes, including the erosive forces of waves and wind and fluctuation of lake elevations (TRPA, 1995). Wave action during high water periods affects the shoreline and can alter beaches. During such events, aerial stems and rootstocks of the plant can be washed away (Josselyn et al., 1992). Wave action can also have a positive benefit for the plant by creating foreshore berms (a relatively flat bench that slopes towards shore and is limited by a steeper slope closer to the lake). Plants may concentrate in low areas created by these berms that offer higher moisture concentrations or protection from wave action.

Under current conditions, dam operations alter the historical seasonal fluctuation of the lake, maintaining higher elevations in spring and summer, the growing season for Tahoe yellow cress (Stone, 1991 as cited in Josselyn et al., 1992). The effect of prolonged inundation on Tahoe yellow cress is not fully known. Although data indicate the species has some mechanism for surviving periods of inundation, maintaining Lake Tahoe at its maximum elevation of 6229.1 feet for long periods of time could adversely affect the survival of certain populations (Josselyn et al., 1992; Ferreira, 1987). In accordance with the Truckee River Agreement of 1935, the legal maximum lake elevation is 6229.1 feet. While the lake has dropped below its rim elevation (6223.0 feet) for extended periods of time during drought situations, the legal maximum elevation has rarely been exceeded for any substantial length of time since 1935.

II. Environmental Consequences

A. Introduction

The Tahoe Yellow Cress Conservation Strategy (Pavlik et al., 2002) lists five major factors that contribute to the current status of the species:

- Alterations in lake level dynamics caused by construction and operations of the Truckee River outlet dam and reservoir
- Destruction of actual and potentially suitable habitat by the construction of piers, jetties, and other structures
- High levels of recreation activities associated with beaches and dunes
- Disturbance of the beach sand by public and private property maintenance activities
- Possible stochastic environmental events

Modifying operations of Truckee River reservoirs could influence Tahoe yellow cress by altering lake level dynamics and changing the amount of available shore zone habitat. In addition, if lake levels were markedly increased at high lake elevations, increases in trampling in the reduced available habitat could adversely affect Tahoe yellow cress. Because the number of populations of Tahoe yellow cress that are present in any given year is dependent upon available habitat, which is determined primarily by the elevation of Lake Tahoe, lake elevation provides the best indicator of change or significant effects caused by changes in management of water in Lake Tahoe.

B. Summary of Effects

Operations model results show that, under TROA, slightly more shore zone habitat is available for Tahoe yellow cress during most months of the primary growing season (May through September) in dry hydrologic conditions than under No Action or current conditions. The greater available habitat, however, is less than 1 percent of the total potential habitat and would not be a significant effect. Under TROA, in median hydrologic conditions, an average of 20 fewer acres are available than under No Action and about 6 fewer acres than under current conditions. Both are differences of less than 1 percent of the total available habitat. In wet hydrologic conditions, under TROA, about the same amount of habitat is available as under No Action, and about 2 acres more than under current conditions. None of these small differences constitute a significant effect (table 3.79).

Table 3.79—Summary of effects: available and total potential habitat for Tahoe yellow cress during the primary growing season (May through September) (+ = significant beneficial effect, - = significant adverse effect)

Hydrologic condition	Compared to current conditions			Compared to No Action	
	No Action	LWSA	TROA	LWSA	TROA
Wet	No effect				
Median					
Dry					

C. Method of Analysis

To determine potential effects, this analysis compared the area of available shore zone habitat in wet, median and dry hydrologic conditions during the primary growing season (May through September), based on lake elevation. Monthly lake elevations from the operations model were used to calculate the habitat area. The maximum modeled lake elevation is 6229.0 feet, where the amount of available shore zone habitat is considered to be zero. The minimum modeled lake elevation of 6220.05 feet corresponds to the maximum available habitat of 2,752 acres. Habitat area markedly decreases area between elevation 6227 feet, when 35 percent (972 acres) of the shore zone is exposed, and elevation 6228 feet, when only 9 percent (238 acres) is exposed (table 3.80).

Table 3.80—Amount of shore zone habitat available at lake elevations 6220 through 6229 feet

Lake elevation (feet)	Shore zone habitat (acres)	Percent of total habitat
6220	2752	100
6221	2401	87
6222	2115	77
6223	1862	68
6224	1658	60
6225	1458	53
6226	1236	45
6227	972	35
6228	238	9
6229	0	0

Soil inundation during the spring and summer inhibits vegetative growth and can delay the onset of flowering of Tahoe yellow cress. Flooding during late stages of the growing season can also inhibit or delay reproduction of the species (Pavlik et al., 2002). The analysis includes a comparison of lake elevations, peak elevations, and declines in elevation during the primary growing season in wet, median and dry hydrologic conditions.

Annual surveys have been conducted for Tahoe yellow cress since 1979 and are annually summarized by CSLC. The 2002 survey report states that the optimal lake elevation to ensure the persistence of the population is 6225 feet or below. Above elevation 6225 feet, there is a statistically significant decline in the number of occupied sites (CSLC, 2003). Lake elevations recorded in the annual surveys and referenced in the CSLC report correspond to the elevation when the annual survey was conducted, generally late August or early September. The operations model generates end-of-month elevations. End-of-August elevations were used to compare the number of years that lake elevations are below 6225 feet, creating preferred conditions for Tahoe yellow cress.

Tahoe yellow cress habitat could also be adversely affected by the concentration of human activities in narrow shore zone habitat areas during high water years. Not only is the amount of habitat greatly reduced at lake elevations above 6227 feet, but recreational activities are concentrated in this narrow zone of habitat, which could increase the trampling of the plants and modify the habitat. Monthly elevations during the growing season (generated from the operations model) were used to calculate the number of years that lake elevations exceeded 6227, 6228, and 6229 feet under each alternative. Elevations that exceeded the selected elevation for any month of the growing season were recorded.

D. Threshold of Significance

Successful implementation of the Conservation Strategy should preclude the need to list Tahoe yellow cress under ESA. Because of its special status, a significant effect would be a reduction in the average amount of shore zone habitat available to the species. Given the understanding of the species biology presented in the Conservation Strategy, it is expected that fluctuations in lake elevations within usual climatic variation are not significant in the long run. Significant adverse effects could occur if increased high water elevations occurred and restricted core populations were not protected from trampling and other habitat destruction, or if elevations were increased and kept atypically high. Signatories to the MOU to implement the Conservation Strategy have committed to protecting sites from trampling at high water.

TRPA has developed a threshold standard for Tahoe yellow cress based on a minimum number of population sites (26) for maintaining the species. The threshold is considered to be in "attainment" when there is a minimum number of populations for the species and the population is protected from adverse effect. TRPA evaluates the species every 5 years and considered the Tahoe yellow cress population to be in "non-attainment" status in 1991, 1996, and 2001 (TRPA, 2002). The threshold of 26 population sites set by TRPA is achievable only in drought years (figure 3.36) and is only met in those years when the lake elevation is at or below 6225 feet. This threshold was not chosen for this analysis because the method is not based on the most current knowledge of the species.

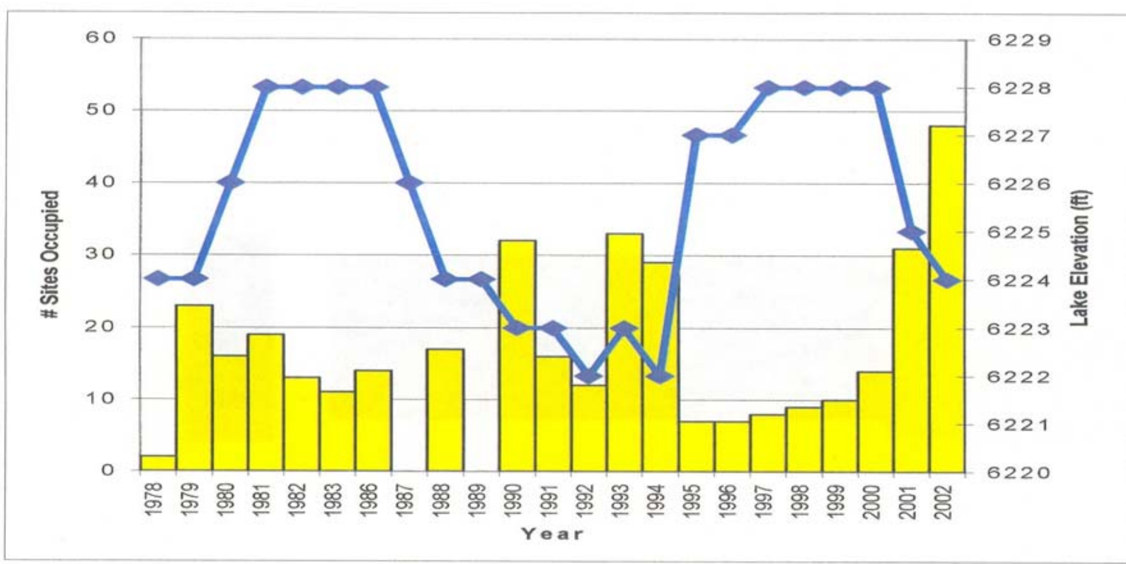


Figure 3.36—Lake elevation and number of Tahoe yellow cress sites occupied, by survey year (blue line = lake elevation) (CSLC, 2003).

E. Model Results

Table 3.81 presents operations model results for the area of available habitat and percent of total potential habitat for Tahoe yellow cress in each month of the growing season.

Table 3.81—Monthly and average growing season available habitat (acres) and percent of total potential habitat based on Lake Tahoe elevations

Hydrologic condition	Month	Current conditions		No Action		LWSA		TROA	
		Acres	Percent habitat	Acres	Percent habitat	Acres	Percent habitat	Acres	Percent habitat
Dry	May	1620	59	1629	59	1630	59	1641	60
	June	1593	58	1604	58	1605	58	1615	59
	July	1642	60	1657	60	1658	60	1674	61
	August	1728	63	1740	63	1741	63	1753	64
	September	1822	66	1833	67	1834	67	1838	67
	Average	1681	61	1693	61	1694	61	1704	62
Median	May	220	8	222	8	222	8	213	8
	June	112	4	122	4	123	4	113	4
	July	158	6	166	6	167	6	160	6
	August	250	9	280	11	282	11	268	10
	September	569	21	592	22	594	22	525	19
	Average	262	10	276	10	278	10	256	10
Wet	May	17	1	20	1	20	1	14	1
	June	0	0	0	0	0	0	0	0
	July	0	0	0	0	0	0	0	0
	August	63	2	63	2	63	2	65	2
	September	134	5	135	5	135	5	139	5
	Average	42	2	44	2	44	2	44	2

F. Evaluation of Effects

1. No Action

Operations model results show that, under No Action, slightly more shore zone habitat is available for Tahoe yellow cress than under current conditions in most months of the primary growing season (May through September) in all three hydrologic conditions. An average of about 12 acres more is available in dry hydrologic conditions; 14 acres more in median hydrologic conditions; and 2 acres more in wet hydrologic conditions.

Under No Action, soil saturation and inundation during the spring and summer, which can inhibit vegetative growth and delay the onset of flowering, would be no greater than under current conditions. The small difference in available habitat between No Action and current conditions represents less than 1 percent of the total potential habitat, and would not be a significant effect.

2. LWSA

Under LWSA, about 1 acre more of shore zone habitat is available in each month in dry hydrologic conditions; up to 2 acres more in median hydrologic conditions, and the same amount in wet hydrologic conditions as under No Action. All differences are less than 1 percent of the total potential habitat for Tahoe yellow cress.

Under LWSA, 12 to 20 more acres of habitat are available in dry hydrologic conditions (an average of 13 acres more) than under current conditions. In median hydrologic conditions, 2 to 32 acres more are available (an average of 16 acres more). Only slightly more habitat is available in May and September in wet hydrologic conditions than under current conditions. The maximum difference, in terms of total potential habitat, is about 2 percent in August in median hydrologic conditions.

Soil saturation/inundation would be no greater under LWSA, and the existing population of Tahoe yellow cress would not be significantly affected by the small differences in available habitat under LWSA compared to either No Action or current conditions.

3. TROA

Under TROA, about 5 to 14 acres more shore zone habitat are available in dry hydrologic conditions (average of 11 acres more) and 6 to 67 fewer acres in median hydrologic conditions (average of 20 acres or less than 1 percent of the total potential habitat) than under No Action. In wet hydrologic conditions, 6 fewer acres are available in May, 2 to 4 acres more are available in August and September, and the same acres are available in June and July as under No Action. On average, under TROA, 2 acres more are available than under No Action in wet hydrologic conditions.

Under TROA, about 16 to 32 acres more shore zone habitat are available in dry hydrologic conditions (average of 23 acres more) and 1 to 18 acres more are available in median hydrologic conditions than under current conditions, except in September, when

44 fewer acres are available. On average, 6 acres fewer are available than under current conditions, a difference of less than 1 percent of the total potential habitat. In wet hydrologic conditions, 3 fewer acres are available in May; 2 to 5 acres more are available in August and September, and the same acres are available in June and July. On average, under TROA, 2 acres more are available than under current conditions in wet hydrologic conditions.

Soil saturation/inundation would not be greater under TROA. The greatest difference in available habitat occurs in September in median hydrologic conditions, when operations model results show 67 fewer acres than under No Action, a reduction in available habitat of only 3 percent at the end of the growing season. Median hydrologic conditions are not as critical to the population dynamics of Tahoe yellow cress as wet hydrologic conditions, when most sites become inundated, or dry hydrologic conditions, when the amount of available habitat exposed expands substantially. Therefore, it was concluded that a minor loss of potential habitat for the Tahoe yellow cress in median hydrologic conditions under TROA is not a significant effect.

G. Mitigation and Enhancement

No mitigation would be required because no significant adverse effects would occur under any of the alternatives.

Island Nesting Water Birds

I. Affected Environment

Anaho Island at Pyramid Lake supports one of the largest breeding colonies of American white pelicans (a California Species of Special Concern) in western North America (Bell and Withers, 2002). The number of nesting colonies in the western United States has declined from 23 to fewer than 10 (Ehrlich et al., 1992). Over the past 25 years, the number of breeding adult pelicans has fluctuated between about 3,000 to more than 21,000. The most recent high of 17,000 breeding adults occurred in 1999. In 2003, there were about 5,000 breeding adults (Withers, 2004). Recent satellite and conventional telemetry studies have shown that individual birds from Pyramid Lake commonly travel throughout northern Nevada and to the Central Valley of California; individuals have been tracked as far east as the Great Salt Lake in Utah and as far south as the states of Guanajuato and Michoacan in central Mexico (Yates, 1999).

There is no estimate of the current American white pelican population. Although the species was in a long-term historical decline until the 1960s, populations have increased through the 1980s (Evans and Knopf, 1993). Based on the North American Breeding Bird Survey, the population trend in the Basin and Range from 1966–2001, where the study area is located, is negative (-9.6 percent per year). These data are acknowledged to have important deficiencies because of the low regional abundance of birds, few survey routes, low precision, and inconsistencies in trend over time (Sauer et al., 2003). The Great Basin as a whole is estimated to support 18 percent of the world's breeding American white pelicans (Carter et al., 1996, as cited in Neel, 1999). The Nevada Partners in Flight Bird Conservation Plan has set an objective of maintaining an average of 4,500 nesting pairs of pelicans at Anaho Island through 2004. This number is based on the yearly averages in the 1980s and 1990s (Neel, 1999). There is presently no access by terrestrial mammalian predators, such as coyotes, to Anaho Island because of the depth of water and distance of the mainland.

Pelicans begin to arrive at Anaho Island the second or third week of March and begin to build nests and lay eggs about the second week of April (Woodbury, 1966). Cui-ui is an important food source for adult pelicans and provide a substantial food source during the early part of the nesting season when there is a cui-ui spawning run (Scoppettone and Rissler, 2002; Scoppettone, 2003). Cui-ui runs occur in higher water years and counts of white pelican adults, nests, and chicks at Anaho Island are strongly correlated with springtime flows (Murphy and Tracy, 2002). When cui-ui ascends the Truckee River in April or May to spawn, they are heavily preyed upon by pelicans.

Primary foods of young pelicans are carp and tui chub. Tui chub is an abundant fish indigenous to Pyramid Lake, and carp is found in nearby wetlands, such as Humboldt Sink, Stillwater Marshes, and Carson Lake (Knopf and Kennedy, 1980). No data are available on the density, availability, or relative proportion of other prey used by pelicans. However, pelicans are opportunistic feeders and will travel great distances to forage on seasonally available fish (Bell and Withers, 2002). Maintaining wetlands and their fish biomass within approximately 62 miles of nesting islands is essential to the continued success of the nesting colony (Knopf and Kennedy, 1980).

California gull nests at Anaho Island in Pyramid Lake and on islands in Lahontan Reservoir. It is currently considered a third priority species, which means that it is not in any present danger of extirpation and its populations within most of its California range do not appear to be in serious decline (CDFG, 2004). The current list is undergoing review: a review draft indicates that California gull does not meet the criteria for inclusion on the new Bird Species of Special Concern List. Currently, there are no identified conservation concerns for this species in Nevada.

The current population of California gull likely contains between 500,000 and 1 million individuals, a number that is likely larger than it was soon after the turn of the nineteenth century (Winkler, 1996). Based on the North American Breeding Bird Survey, the population trend in the Basin and Range from 1966–2001 shows an increase of 3.2 percent per year. Because of the highly colonial nature of the California gull, estimates based on transects (such as the Breeding Bird Survey) are not likely to provide a very accurate picture of bird abundance (Winkler, 1996).

Since 1950, the number of California gull nests on Anaho Island has ranged from1,000 to 3,300 (FWS, 1990). There are approximately 3,000 pairs of California gulls in colonies on islands in Lahontan Reservoir (Yochem et al., 1991). The California gull colony at Lahontan Reservoir is the largest of the few colonies in Nevada (Yochem et al., 1991); it is not known whether gulls from this colony move to other colonies in California or elsewhere to breed. Both food supply and a nesting sanctuary are key factors in the nesting success of this species (Gaines, 1988).

In other locations, there is limited genetic exchange between isolated colonies. California gull population structures typically are islands that experience some genetic exchange through breeding individuals that disperse among populations (Pugesek, 1996). There are no data on the importance of individual colonies to the species as a whole (Shuford, 1996) or how many individual colonies are necessary to maintain a level of genetic exchange to ensure genetic viability. Like most California gull colonies, the Lahontan Reservoir population is relatively small; of the 206 known breeding colonies only nine supported more than 20,000 birds (Winkler, 1996). The genetic influence of the Lahontan population on the total California gull population, therefore, may be small (Winkler, 1996).

California gulls were first documented nesting on islands in Lahontan Reservoir in 1939 (Alcorn, 1988). Since then, lake elevation data show that the main nesting island (Gull Island) has been landbridged in 26 percent of the years during the gull nesting season and the smaller island (Evans Island), which has a small population of California gulls and other species, has been landbridged in 7 percent of the years from 1939 to 1996. The stability of the population of California gulls at Lahontan Reservoir is unknown (Yochem et al., 1991).

It is also not known what effect historic predation has had on the population of gulls and other colonial nesting species at Lahontan Reservoir; however, colonial species have continued to use these islands over time despite past land bridging.

II. Environmental Consequences

A. Introduction

Two indicators were selected to evaluate effects on island nesting birds:

- American white pelican prey availability (based on two indicators from the cui-ui analysis: average annual inflow to Pyramid Lake and the frequency that flow regime 1, 2, or 3 is achieved in the lower Truckee River from April through June)

- Predator access to California gull nesting islands in Lahontan Reservoir

B. Summary of Effects

The summary of effects on American white pelican prey availability is the same as discussed in "Cui-ui" for the indicators of average annual inflow to Pyramid Lake and the frequency that flow regime 1, 2, or 3 is achieved in the lower Truckee River from April through June.

Operations model results show that, under TROA, mainland predators could access California gull nests on islands in Lahontan Reservoir 1-2 percent more frequently than under current conditions and the same or 1 percent more frequently than under No Action (or LWSA). There would be no effect on California gull nesting.

C. American White Pelican Prey Availability

See "Cui-ui" for discussions of methods of analysis, thresholds of significance, model results, evaluations of effects, and mitigation and enhancement.

D. Predator Access to California Gull Nesting Islands in Lahontan Reservoir

See "Waterbirds and Shorebirds" for discussions of method of analysis, model results, and evaluation of effects.

1. Threshold of Significance

No scientific data exist to support an absolute numeric threshold for the frequency of predator access that would constitute a significant adverse effect. A significant adverse effect on the population of California gulls at Lahontan Reservoir would occur if predation caused it to decline below a self-sustaining level (this level is unknown)or if the colony were abandoned and the gulls were not able to establish a new colony or breed elsewhere. If gulls abandoned Gull Island, they may move to Evans Island or to other historic nesting sites in the Carson Sink or Stillwater National Wildlife Refuge if appropriate conditions (high water) were to exist (Neel, 1997). In other locations, when adults abandon a colony as a result of predation, it is not known where they go or if they breed elsewhere (Shuford, 1996).

Landbridging has occurred in the past at Lahontan Reservoir, and California gulls continue to breed successfully at this site. The determination of significance, therefore, was based on best professional judgment.

2. Mitigation and Enhancement

Operations model results show that the elevation of Pyramid Lake never falls below the threshold under current conditions and the alternatives. Predator access to islands in Lahontan Reservoir where California gulls nest occurs slightly more frequently under TROA, but the difference is too small to constitute a significant adverse effect. No mitigation, therefore, would be required.

Osprey

I. Affected Environment

Osprey are known to nest at Stampede Reservoir and Lake Tahoe. This species also is known to nest along the Little Truckee River. In the California portion of the study area there may be other pairs of nesting osprey, but the sites have yet to be documented (Jurek, 2003).

II. Environmental Consequences

Live fish comprise at least 99 percent of osprey prey items (Poole et al., 2002). A wide variety of fish species are taken but often only two or three species account for the majority of prey taken in any one area. Inland osprey forage along rivers, mashes, reservoirs, and natural ponds and lakes, in both shallow and deep water. Reservoirs often provide ample expanses of shallow, clear water that provide ideal conditions for hunting. Nesting densities also show a preference for shallow water. Periods of low water can lead to reduced prey availability due to the prolific growth of aquatic vegetation (Poole et al., 2002) Effects on osprey were, therefore, based on analyses of the effects on the primary prey base of osprey, live fish in lakes and reservoirs, the same indicator as for bald eagle. See “Bald Eagle” for discussions of summary of effects, method of analysis, threshold of significance, model results, evaluation of effects, and mitigation and enhancement.

Habitat for Other Special Status Plants

I. Affected Environment

In addition to Tahoe yellow cress, eight plants, one lichen, and two mosses may occur in the study area and potentially could be affected by modifying operations of Truckee River reservoirs. These plant species and their habitats are discussed below.

A total of 32 other special status plants known or likely to occur within the study area were evaluated. Most occur in upland habitats or other non-riparian/riverine habitats that would not be affected by the alternatives. A list of these species is included in the Biological Resources Appendix.

Shore sedge, on CNPS List 2, is rare in California but has a widespread, patchy, distribution elsewhere in western North America. It is typically associated with sphagnum but may also be found along lake, pond, and small stream margins. It is unlikely to occur along the mainstem of the Truckee River, but could potentially be found along the upper tributaries. It is know to occur in the Sagehen Creek drainage, upstream of Stampede Reservoir (CalFlora, 2004; CNPS, 2003; Hickman, 1993).

Grants Pass willowherb, on CNPS List 1B, is also rare in California where is primarily found in the Klamath Mountains. It is also known from the adjacent Siskiyou Mountain in Oregon, where it is considered rare. Like the shore sedge, it typically is found with sphagnum but may also be found along small streams. It is known to occur in the Sagehen Creek drainage, upstream of Stampede Reservoir (CalFlora, 2004; CNPS, 2003; Hickman, 1993).

American manna grass, on CNPS List 2, is extremely rare in California, which lies along the southern edge of this more northerly species' range. Its typical habitats include meadows, lakes, and stream margins. Within the study area, it has been documented from the vicinity of Squaw Creek near the Truckee River (CalFlora, 2004; CNPS, 2003; Hickman, 1993).

Marsh skullcap, on CNPS List 2, is a circumboreal species, which is rare in California. It may be found in wet meadows and along streambanks. It was collected in 1884 near Truckee and is known to occur in the Lake Tahoe basin (CalFlora, 2004; CNPS, 2003; Holst and Ferguson, 2000; Hickman, 1993).

Plumas ivesia, on CNPS List 1B, occurs only in a few northern Sierra counties where it may occur in wetlands. Within the study area, there are numerous known locations in the Sagehen Creek drainage upstream of Stampede Reservoir and in Martis Valley east of Truckee (CalFlora, 2004; CNPS, 2003; Hickman, 1993).

Slender-leaved pondweed, on CNPS List 2, always occurs in wetlands typically in shallow, freshwater marshes and lakes. It is a circumboreal species that is rare in California. It was collected in 1931 from Lake Tahoe; it is also documented from Sierra County (CalFlora, 2004; CNPS, 2003; Hickman, 1993).

White-stemmed pondweed, on CNPS List 2, always occurs in wetlands, typically in deep water and lakes. It is a circumboreal species that is rare in California. Although it has not been reported from the study area, it is documented from adjacent Sierra County (CalFlora, 2004; CNPS, 2003; Hickman, 1993).

Water bulrush, on CNPS List 2, is known from lake margins and water edges. It is a more northerly species which reaches the southern limit of its distribution in California. It is not known from the study area but has been documented from the Lake Tahoe basin (CalFlora, 2004; CNPS, 2003; Hickman, 1993).

The veined water lichen, a USFS Sensitive Species, is freshwater lichen that ranges from the Sierra Nevada north to Alaska. It grows in clear, mid- to high-elevation streams where water quality appears to be very good. This aquatic lichen grows primarily on small to medium rocks or bedrock and occasionally on wood, or partially buried in loose gravel (Derr, 2000). Within California, it is known from only a few streams from Calaveras County south to Tulare County (Shevock, 1996).

The three-ranked hump-moss, a USFS Sensitive Species and California Species of Special Concern, and the broad-nerved hump-moss, a Forest Service Sensitive Species, are aquatic mosses. Both are on CNPS List 2 and occur in meadows and seeps and other wetland habitats in the Sierra Nevada. The three-ranked hump-moss is known to occur in the Sagehen Creek drainage upstream of Stampede Reservoir. The broad-nerved hump-moss, has not been documented to occur in the study area (CNPS, 2003).

II. Environmental Consequences

The relation between riparian-associated and aquatic special status plant species and their habitats has been described. As with other riparian plants, changes in riparian habitat can be used to assess the probable effects of the various scenarios on special animal species. Moreover, since the effects on riparian habitats are based on average monthly flows, the same analysis can be used for special status aquatic plant species. A single indicator, therefore, was chosen for other special status plant species: relative amounts of riparian habitat. See “Riparian Habitats and Riparian-Associated Wildlife” for discussions of summary of effects, method of analysis, threshold of significance, model results, evaluation of effects, and mitigation and enhancement.

Habitat for Other Special Status Animal Species

I. Affected Environment

In addition to the individual animal species previously discussed, 12 other species of mammals, birds, fishes, invertebrates, amphibians, and reptiles listed by either the State of California or Nevada, or otherwise accorded special status occur within the study area and could potentially be affected by modifying operations of Truckee River reservoir. These species are discussed by their habitat relationships as follows.

An additional 37 species of mammals, birds, and invertebrates known or likely to occur within the study area were evaluated. Most occur in upland habitats or other non-riparian/riverine habitats that will not be affected by the alternatives under consideration. A list of these species is included in the Biological Resources Appendix.

A. Palustrine Emergent Wetlands

Four special status species have a primary association with emergent wetlands within the study area: northern leopard frog, northwestern pond turtle, northern harrier, and long-billed curlew.

The distribution of northern leopard frog, a Forest Service Sensitive Species, appears to have been severely reduced along the Truckee River and now occurs along a reach of the lower river approximately 10 miles upstream of Pyramid Lake (Panik, 1992; Panik and Barrett, 1994; Ammon, 2002b). Breeding habitat is described as off channel wetlands such as oxbows, spring heads and, spring outflows (Ammon, 2002b). Breeding has been documented along the lower Truckee River in permanent wetland areas, but the population is considered extremely small and vulnerable to extinction (Ammon, 2002b). Northern leopard frogs use many different habitat types along this section of river; therefore, it is critical that all riparian habitat types are protected and that the river and riparian areas function properly for this species to survive. Non-native bullfrogs are found throughout this same section of the Truckee River and pose a considerable threat to the continued existence of northern leopard frog (Panik and Barrett, 1994; Ammon, 2002b).

Northwestern pond turtle, a USFS Sensitive Species, occurs in Nevada mostly along the Carson River, although some individuals may persist in a few sites along the Truckee River (Jennings et al., 1992). The species inhabits rivers, tributaries, ponds, lakes, marshes, oxbows, and other seasonal and permanent wetlands (Stebbins, 1985; Reese and Welsh 1998). Channelization of streams and rivers reduces or eliminates critical habitat such as slow, deep pools with large woody debris and stable undercut banks (Reese, 1996). Introduced species are the primary predators on juvenile turtles (Reese 1996; Hays et al. 1999). Bullfrogs have been reported as preying on juvenile turtles (Hays et al., 1999) and are considered a primary threat to juvenile survival and population recruitment (Ammon 2002b). Eggs, juveniles, and adults on land also face a myriad of predators including raccoon, coyote, red fox, and ravens (Ammon, 2002b). Females may leave the riparian corridor to excavate a nest site in uplands, and individuals over winter away from watercourses in upland areas (Jennings et al., 1992; Reese, 1996). The relative amount of palustrine emergent wetlands and affected pond-like areas is an indicator of how changes in flows may affect this species.

Northern harrier, a California Species of Special Concern, has greatly declined as a breeding bird in California where it is now considered a permanent resident only of the northeastern plateaus, coastal areas, and the Central Valley. Although it is known to breed at up to elevation 5,700 feet in the Sierra Nevada, it does not frequent forested areas. It was not observed during surveys along the Truckee River and its tributaries (Lynn et al., 1998). Northern harrier is a common permanent resident at many locales throughout the Great Basin. In both California and the Great Basin, it is most often associated with marshes and agricultural areas (CPIF, 2000; NDOW, 1985; Ryser, 1985). It is frequently observed during Christmas bird counts in the Truckee Meadows and Pyramid Lake areas (Clark, 1998; Eidel and Clark, 1999; Floyd and Eidel, 2000).

Long-billed curlew, a California Species of Special Concern and FWS Bird of Conservation Concern, is not known from the study area in California but is a migrant and known to breed in the Great Basin of Nevada where it has been declining as a result of agricultural and other land development (Ryser, 1985). It was observed infrequently during surveys along the lower Truckee River (Lynn et al., 1998), and was recorded as common in 1868 (Klebenow and Oakleaf, 1984). Long-billed curlew prefers closely cropped grasslands, pastures, wet meadows, and dry meadows (usually associated with water), either on the fringe of a marsh, in a meadow, or on a broad floodplain (Neel, 1999).

B. Palustrine Scrub-Shrub Wetlands

Four special status animal species are known to be closely associated with scrub-shrub wetlands within the study area: willow flycatcher, yellow warbler, yellow-breasted chat, and Nevada viceroy.

Willow flycatcher, a California Endangered species and a USFS Sensitive Species, is associated primarily with montane riparian habitats. The species has declined in California and, although breeding populations remain in a few strongholds in the Sierra Nevada, in recent surveys, 53 of 135 known sites were found to no longer support willow flycatchers. Willow flycatcher in the Sierra Nevada is considered a population in peril (Green et al., 2003). Within the study area, only two of the seven known breeding sites in the Lake Tahoe Basin Management Unit were active, a decline of 71 percent; in the Tahoe National Forest, the number of active sites has declined from 18 to 14, or 22 percent. Willow flycatchers occur along the Little Truckee River where suitable habitat occurs in broad, flat meadows that are generally larger than 19.8 acres, contain free water, and have 50-70 percent cover of patchy willow thickets at least 6.6 feet tall (Sanders and Flett, 1989). They are also known to occur southwest of Independence

Lake (Serena, 1982), and along the Upper Truckee River (Lynn et al., 1998). Although the range of the willow flycatcher is known to extend eastward into the Great Basin of Nevada, its status there is poorly understood (Neel, 1999). The most recent records from the lower Truckee River are museum specimens taken from the Reno area in the late 1960s (Alcorn, 1988). Direct threats to the species in the Sierra Nevada include poor meadow conditions that increase erosion and brown cowbird parasitism, water diversion, recreation, and roads (Green et al., 2003).

Yellow warbler, a California Species of Special Concern, is declining over much of the United States, especially in the West, and particularly in California and Arizona (Ehrlich et al., 1992). California populations are much reduced and have been extirpated in some areas (Remsen, 1978). In the early 1990s, yellow warblers were found in all reaches of the Truckee River in relatively high numbers (Lynn et al., 1998) and they remained common along the lower Truckee River through 2001 (Ammon, 2002a). Optimal nesting habitat is provided in wet areas with dense (60 to 80 percent) crown cover and moderately tall (6.6 feet or greater) stands of willow and alder of at least 0.37 acre (Schroeder, 1982).

Yellow-breasted chat, a California Species of Special Concern, was once a common summer resident in riparian woodlands throughout the State, but is now much reduced in numbers. It nests in riparian scrub and cottonwood-willow habitats and was observed along the lower Truckee River in small numbers in the early 1990s (Lynn et al., 1998). It was not seen along the upper Truckee River or its tributaries during these surveys. During surveys in 1998 and 2001 it was reported as common along the lower Truckee River, attributed to a substantial increase in early successional riparian shrublands (Ammon, 2002a).

Nevada viceroy, considered critically imperiled in Nevada, is a butterfly known only from Nevada where it is found primarily along the Humboldt River. Additional colonies are known in the study area near Fallon and Fernley. It occurs only in the immediate vicinity of willows, which are its larvae host plant (Austin, 1990).

C. Palustrine Forested Wetlands

One special status species, Swainson’s hawk, is associated with riparian forests. It is a State of California Threatened species and FWS Bird of Conservation Concern. Once found throughout the Central Valley (but absent from the Sierra Nevada), today it is restricted to portions of the Central Valley and the Owens Valley in the Great Basin (CDFG, 2000). In Nevada, Swainson’s hawk is a resident from April through October. Although it was described in 1877 to be “one of the most abundant of the large hawks of the interior” (Ridgway, 1877), a decline of 20.4 percent was identified by the Breeding Bird Survey in the Basin and Range Province from 1966 to 1979.

Since 1980, the population has shown an increasing trend of about 3.8 percent. In Nevada, Swainson's hawks reside in agricultural valleys interspersed with cottonwood trees or on river floodplains with cottonwood trees (Neel, 1999). Swainson's hawks have not been observed during recent surveys along the Truckee River (Lynn et al., 1998).

D. General Riparian or Aquatic Habitats

Aquatic special status species occurring within the study area and potentially affected by changes in reservoir operations include a fish, mountain sucker, and three aquatic invertebrates: California floater, Great Basin rams-horn, and a moth. Mountain sucker, a California Species of Special Concern, has a wide distribution in the western United States although the population within the Truckee River has long been isolated from all others. It typically inhabits clear streams with moderate gradients; 10–50 feet wide and less than 6 feet deep; with rubble, sand, or boulder bottoms. It also can live in large rivers and turbid streams. Although found in lakes and reservoirs, it is absent from Lake Tahoe and Pyramid Lake. It does not persist in reservoirs, which usually flood habitat and isolate populations. In California, only small populations susceptible to extirpation remain. Within the study area in Nevada, high densities of mountain sucker may exist in the Truckee River upstream from Reno (Moyle, 2002).

California floater, a freshwater mollusk, is considered critically imperiled in Nevada. It occurs in lakes and fairly large streams or slow rivers. It is generally found on soft substrates such as mud or sand (Frest and Johannes, 1995). The original distribution included the Pacific Northwest, south to the northern San Joaquin Valley of California. It has apparently been extirpated from Utah and has a very limited distribution in Arizona. In the 1880s, California floater was found sparingly in the Truckee River (Call, 1884). It is clearly declining in numbers and in area occupied throughout its range.

Great Basin rams-horn, also a freshwater mollusk, occurs in larger lakes and slow rivers including springs and spring-fed creeks, usually in areas with soft substrates and clear, very cold, slowly flowing water (Frest and Johannes, 1995). The species historically occupied 14 widely distributed sites throughout the western United States; few sites survive. Within the study area, it has been reported from Lake Tahoe and the adjacent slow segment of the Truckee River (Taylor 1981, as cited in Frest and Johannes, 1995).

The aquatic moth, considered critically imperiled in Nevada, is a widespread western North American species found in well-oxygenated water of streams and lakes. The adult female usually deposits eggs on the underside of rocks. In northern California, two to three generations of this species occur a year (Lange, 1984). Larvae are most abundant in lakes and streams where the water velocity is between 0.4 and 1.4 meters per second (Tuskes, 1981 as cited in Lange, 1984). They are generally shredders-herbivores that feed on aquatic plants. This species was identified in a recent during a recent study of the invertebrate communities of Pyramid Lake (Alexandrova, 2003).

Riparian habitat sustains four species of bat: pallid bat, pale Townsend's big-eared bat, western red bat, and the fringed myotis. The first two are USFS Sensitive Species and California Species of Special Concern. Pallid bat is unusual in that it feeds almost entirely on prey captured on the ground; it may on occasion roost in tree cavities, including cottonwoods. Pale Townsend's bat may forage in riparian areas. Western red bat, a USFS Sensitive Species, roosts only in tree foliage and is closely associated with lowland riparian forest in arid areas. Fringed myotis, considered imperiled in Nevada, is typically a woodland species at middle elevations in the mountains, but may also be found in more arid environments.

II. Environmental Consequences

The relation between riparian-associated and aquatic special status animal species and their habitats has been described above. As with other animal species, changes in riparian habitat can be used to assess the probable effects of the various scenarios on special animal species. Moreover, since the effects on riparian habitats are based on average monthly flows, the same analysis can be used for special status aquatic animals. A single indicator, relative amounts of riparian habitat, therefore, was chosen for special status animal species. See "Riparian Habitats and Riparian-Associated Wildlife" for discussions of summary of effects, method of analysis, threshold of significance, model results, and evaluation of effects. Because of the benefits and enhanced environmental conditions under TROA, no mitigation would be required. Riparian habitat for riparian-associated and aquatic special status animal species would be enhanced under TROA.